Call for Proposals

Storage Technology

HIRP OPEN 2017

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Application Deadline: 09:00 A.M., 16th June, 2017 (Beijing Standard Time, GMT+8).

If you have any questions or suggestions about HIRP OPEN 2017, please send Email

(innovation@huawei.com). We will reply as soon as possible.

Catalog

HIRPO2017040301: Research on advanced solid electrolyte for long cycle life lithium-metal battery

1 Theme: Storage Technology

2 Subject: Battery Energy Storage Technology

List of Abbreviations

NA

3 Background

Lithium ion batteries have achieved commercial success in many applications, including 3C, EVs, and energy storage system. However, the safety concern and the requirement for high energy density are driving greatly the R&D of lithium ion battery. Solid electrolyte in solid state lithium ion batteries is more and more attractive since it has the potential to work with lithium metal anode and various (high voltage/capacity) cathode to delivery high power and energy, and at the meantime to prevent the lithium dendrite growth. Therefore, innovative study on advanced solid electrolyte with Li^+ superionic conductivity and enhanced stability at the interface against lithium metal anode and against cathode are vitally important to fulfill the demands for higher energy density, better safety and longer cycle life.

4 Scope

As a key component in solid state lithium ion batteries, solid electrolyte has its drawbacks. Currently, the conductivities of solid electrolytes only reach useful value (10^{-2} S/cm) at elevated temperatures, which is much lower than those of liquid electrolytes. In addition, the solid-solid interface between electrolyte and electrodes has large interfacial resistant for Li^+ transporting, and is not stable during cycling. Therefore, it's highly important to investigate advanced solid electrolyte with Li^+ superionic conductivity at room temperature; and meanwhile, to explore the interface property between solid electrolyte and electrodes (especially lithium metal anode), in the purpose to enhance the solid state battery performance and cycle life.

5 Expected Outcome and Deliverables

Expected deliverables for the project: solid state Li^+ superionic conductors (with expected conductivity around 10^{-2} S/cm at room temperature), which has large electrochemical window (stable up to 5.5 V); improved interface between the solid electrolyte and lithium-metal anode; improved interface between the solid electrolyte and the cathode; improved cycle life, solid state battery delivery high energy density for more than 200 cycles with 80% capacity retention at room temperature.

6 Acceptance Criteria

Solid state Li^+ superionic conductors (around 10^{-2} S/cm at room temperature), wide electrochemical window (stable up to 5.5 V); improved interface especially against lithium-metal anode; all solid state battery with good cycle performance (>200 cycle 80% capacity retention).

7 Phased Project Plan

Phase1 (~4 months): Development solid electrolyte with conductivity around 10^{-3} S/cm at room temperature; investigate the interface property against lithium metal.

Phase2 (~8 months): Development solid electrolyte with conductivity around 10^{-2} S/cm at room temperature; improve and stabilize the interface against lithium metal, and against cathode.

Phase3 (~4 months): Build all solid state lithium ion battery delivering high energy density, with good cycle performance up to 200 cycles with 80% capacity retention at room temperature.

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HIRPO2017040302: Enhanced safety for the lithium Ion battery

1 Theme: Storage Technology

2 Subject: Battery Energy Storage Technology

List of Abbreviations

NA

3 Background

With the growing demand for mobile power sources, the application of lithium ion batteries expanded from consumer electronics to electric vehicle and energy storage fields. Since the single cell energy continues to improve, the loss and damage caused by battery safety accidents is growing. The battery safety incidents not only bring material and spiritual problems to the consumer, but also cause huge economic losses to the manufacturers. Innovation in battery safety diagnosis and protection technology is thus urgently needed to improve the safety of lithium ion battery.

4 Scope

Under abuse conditions, the temperature of lithium ion battery will reach higher than the aluminum current collector melting temperature (~700^{o}C), resulting in the battery smoke, fire, explosion or even the occurrence of personal injury. Therefore, the safety of lithium ion battery not only refers to the pass of the safety test, to ensure the personal safety issue is more important. At present, the safety incidents continue occurring, it is obvious that the existing battery safety diagnosis and protection technologies cannot meet the ever increasing requirements.

5 Expected Outcome and Deliverables

Battery safety diagnostic technologies, indicating the possible safety risk control from the material, cell design and manufacturing

On-line diagnostic technologies of battery safety during battery operation.

Protection technology for the detected safety risk, which is able to minimize the fire accidents from 2 ppm to below 0.5 ppm.

6 Acceptance Criteria

Quantitative battery safety diagnostic technologies, indicating the possible security risk from the material, design and manufacturing point of view.

Quantitative on-line diagnostic technologies of battery safety during battery operation.

Protection technology for the detected safety risk, which is able to minimize the fire accidents from 2 ppm to below 1 ppm.

7 Phased Project Plan

Phase1 (~6 months): Qualitative battery safety diagnostic technologies, qualitative on-line diagnostic technologies.

Phase2 (~6 months): Quantitative battery safety diagnostic technologies, quantitative on-line diagnostic technologies, protection technology proposed.

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HIRPO2017040303: Long distance wireless charging for smartphone

1 Theme: Storage Technology

2 Subject: Wireless Charging Technology

List of Abbreviations

NA

3 Background

In recent years, wireless charging technologies develops very fast. It is convenient for portable and wearable device compare with wired charging. Among the commercial wireless charging solutions, magnetic coupling with 100-300Khz and 6.78Mhz are dominant. It can provide contactless charging, but the charging device is still confined at a distance of several mm to several cm within the transmitter. This project is researching a safe and long distance charging technology for a portable device, like a smartphone. It can provide several meters freedom for the user.

4 Scope

The wireless charging system consist of a transmitter and 3 receivers. The transmitter can charge the 3 receivers at the same time. At a distance of 5m, the charging power is above 3W for each receiver and above 5W at distance of 3m. The system efficiency (form AC to battery) is higher than 20%. The receiver need to be small enough and has the possibility to be integrated into a smartphone. The technology is not constrained, for example microwave, laser, ultrasonic etc. But it must compatible with generally accepted safety standard.

5 Expected Outcome and Deliverables

Expected deliverables for the project: functional demo, prototype,

6 Acceptance Criteria

Chargeable region: Height=4m, radius=4m cone area (surpose the transmitter is at the top of cone)

Output power: ≥3W 5m; ≥5W 3m

Min number receiver: ≥3

System efficiency: ≥20%（220Vac to Li Battery）

Charging method: not constrained

Size of receiver: area≤200mm^2；thickness≤4mm (preliminary)

7 Phased Project Plan

Phase (~12 months): Expected project will duration 1 year.

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HIRPO2017040304: Failure mechanisms research and failure mode construct for specified large capacity Li-ion battery

1 Theme: Storage Technology

2 Subject: Li-ion Battery

List of Abbreviations

DOD	Depth of discharge
SEI	Solid electrolyte interface
SEM	Scanning electron microscope
XPS	X-ray photoelectron spectroscopy

3 Background

Due to its high energy density and power density, lithium ion battery has been widely used in telephones, laptop computers, backup power and electric vehicles and so on. However, failure problems such as safety issues and life degradation in many user scenario is an obstacle to the application of the large-scale energy.

To understand the effects of battery life and the degradation mechanism in depth will help us optimize the using strategy and prolong battery life. Also, a thorough study of the safety issues failure mechanism will help reduce safety risk during using and management battery.

Moreover, failure modes are indicators of the battery's aging and safety state. Failure mode analysis and construct will help us verify the mechanism and estimate the battery's status.

Nowadays, the failure mechanism and failure mode of battery are still not very clearly. Therefore, the research direction is valuable and will help us improve the ability of using and management battery.

4 Scope

Failure mechanisms research and failure mode construct for Li-ion battery

1) Failure for life degradation:

Investigate the effects of specified battery life degradation (include effects for calendar life and cycle life, such as temperature, △DOD, DOD, rate, and so on) and the internal mechanism of the life degradation, including the mechanism of capacity degradation (such as which part active materials dissolution, lithium deposition and so on), power degradation, resistance increase (such as why the SEI thickened, collector corrosion and so on) and their validation.

2) Failure for safety issues:

Investigate the specified battery's failure mechanism (such as electrolyte decomposition, lithium deposition, and separator shrinkage and so on) and external characters of safety issues, include over discharge, over charge, internal and external short circuit, over temperature, over pressure, over current, and their validation.

5 Expected Outcome and Deliverables

- Technical reports of battery life degradation failure mechanisms analysis and failure mode construct include:

  Reports for design of experiment, such as method for construct aging battery, method for mechanism validation;

  Test records such as data, video;

  Reports for analysis after battery disassemble such as SEM, XPS;

  Reports for research conclusion (relationship between battery aging external character and their internal mechanism).

- Technical reports of battery safety issues failure mechanisms analysis and failure mode construct include:

  Reports for design of experiment, such as method for construct safety issues failure, method for mechanism validation;

  Test records such as data, video;

  Reports for analysis after battery disassemble;

  Reports for research conclusion (relationship between external character and their internal mechanism of battery safety issues failure).

6 Acceptance Criteria

Project proposal is accepted by evaluation team, Huawei.

The failure mechanism and failure mode analysis should be prove by experiment data including data after disassemble the battery.

7 Phased Project Plan

Phase1 (~2 months): Survey state of the art of the battery aging and safety failure mechanism and failure mode; detailed experiment design.

Phase2 (~8 months): Report progress monthly

1) Battery degradation failure mechanisms research and failure mode construct and their validation;

2) Battery safety issues failure mechanisms research and failure mode construct and their validation.

Phase3 (~2 months): Provide reports.

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HIRPO2017040305: Research on Active-Active distributed cache

1 Theme: Storage Technology

2 Subject: In-memory NoSQL Database

List of Abbreviations

NA

3 Background

Redis is an open source in-memory data store, which is used to provide a distributed cache service in public cloud. The “Active-Active” distributed cache is known as the dual active or multiple active distributed cache, which is to provide high available and easy recovery from disaster. In active-active distributed cache, users can access to replicated databases for load balancing and high availability across all available processing capacity. Failure of a node/cluster automatically switches users to another node/cluster. The scalability of distributed cache leads to new problem: consistency, fault-tolerance and migration/replication.

Different applications have different demands for the level of consistency, strong consistency, eventual consistency, and weak consistency. For many applications, strong consistency is not required, eventual consistency achieved in a limited time can meet the demand. To reduce the time overhead of consistency is important to help distributed cache provide efficient service for users. Moreover, in distributed cache, there may be data loss due to abnormal circumstances, and thus data consistency cannot be guaranteed, even eventual consistency.

For distributed cache, to find a balance point between the cost of a single point fault and distributed replication is important. If the single point fault is good, the number of distributed replication can be reduced, and the overhead of consistency can be reduced. In-memory DB has the problem of power protection, and data will be lost when power is off.

To increase or remove a node in the Redis cluster, data will be migrated and data distribution will be re-adjusted. As the global hash consistency is used, migration is very slow in the case of large amounts of data. Currently, a key in each slot is migrated one by one. Due to the poor algorithm of internal migration algorithms in Redis, the migration process is slow. In distributed cache, data is replicated from one cluster to another cluster, how to provide efficient and fast replication is also important.

ARM64 is attractive in data center due to its low power and low cost. How to take the advantage of ARM64 in distributed cache is an essential issue. For example, ARM64 has more cores than x86, but Redis is single-thread, one problem is how to use the multiple cores in ARM64.

4 Scope

The candidates is expected to deploy some deep research on active-active distributed cache. Topics of particular interest of active-active distributed cache include, but not limited to:

1) Propose quantitative method of consistency, according to different levels of data consistency, optimize the allocation of resources, and provide controllable consistency level.

2) Provide efficient active-active distributed cache architecture while guaranteeing performance and consistency, and evaluate the data

consistency. Reduce the amount of data transmission, and reduce the time overhead of consistency.

3) Propose efficient fault-tolerance for distributed cache to reduce the overhead of consistency.

4) Improve the migration algorithm to improve the efficiency of migration and improve the replication algorithm in distributed cache while ensuring data consistency and service availability.

5) Optimize Redis in the ARM64 environment, and take advantage of ARM64 in distributed Cache.

5 Expected Outcome and Deliverables

- The state-of-the-art investigation report of active-active distributed cache.
- Technical reports of active-active distributed cache, including algorithms.
- Related simulation/evaluation platform with source codes and description.
- 1~2 Invention/patents, and 1~2 Publications in peer-reviewed Journals or top ranked conferences.

6 Acceptance Criteria

The proposed mechanism can provide efficient active-active distributed cache. The benefit is reasonable theoretically, from the perspectives of active-active distributed cache, and proved by the simulation evaluation.

Project proposal is accepted by the evaluation team, Huawei.

Project deliverables are accepted by the evaluation team, Huawei.

7 Phased Project Plan

Phase1 (~3 months): survey the state of the art of active-active distributed cache, analyze and build the efficiency architecture and provide the related technical report.

Phase2 (~6 months): Research on active-active distributed cache to optimize Redis, and provide algorithms, and the related technical report.

Phase3 (~3 months): Research and provide related simulation results, research publications and patents.

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HIRPO2017040601: Cloud File System Key Technology Research

1 Theme: Storage Technology

2 Subject: Distributed File System

List of Abbreviations

CloudFS: Cloud File System

AZ: Available Zone

AA: Active/Active Mode

3 Background

Unstructured data and metadata continue to grow upwards of 62% on average per year. Traditional means of storing data, like NAS, do not scale quickly or economically enough to accommodate the growth in demand from massive expansion in data generated by individuals and organizations. AWS, Azure, Aliyun have redesigned file system for cloud service, and Panzura, NASUNI provide global file system based on cloud storage.

Build a high efficiency cloud file system never be an easy work, we need to design the policy of cross AZ and cross sites. To make the performance better, we should also consider the cache architecture and data transferring policy of different sites.

Our object is building a cloud-native file system to meet the enterprise requirements of unstructured data storage.

4 Scope

Key technology 1: Design the cross AZ cloud file system

Based on the cross-AZ distributed storage pool, design a high performance cloud file system, including data consistent policy, cache policy, and lock policy. When network is not the bottle neck, the performance of the file system should exceed 100MB /TB. In the first version, we can design a master write (write request route to master replica) architecture that only one node accept write request and all the replica can response for read request.

Key technology 2: Design the global file system based on cloud storage

Base on cloud storage, like S3, build a global distributed file system and solve the key technical problems. The key technologies include cross-site data layout design, cross-site AA policy and cross-site cache architecture.

5 Expected Outcome and Deliverables

1. Cross-AZ distributed file system architecture design and detail design documentations.
2. Cross-AZ distributed file system demo and experiments data.
3. Global file system architecture design and detail design documentations.
4. Global file system demo and experiments data.

6 Acceptance Criteria

1. The design of the cross-AZ distributed file system is complete and reasonable, and the demo can easily deploy and run. And the performance achieves the bottle-neck of the low level storage pool.
2. The design of the global file system is complete and reasonable, and the demo can easily deploy and run. And the performance is similar with the

local storage.

7 Phased Project Plan

Expected project Duration (year): one year

Project Phase	Start time	End time	Work content	work goals	Output
Phase 1	T	T+4	1) Give the architecture design and detail design of cross-AZ file system; 2) Complete the design of the global file system.	1) Give the architecture design and detail design of cross-AZ file system; 2) Complete the design of the global file system.	File system demo and experiments data.
Phase 2	T+4	T+12	1) Build the demo of cross-AZ file system and give out the test data 2) Build the demo of global file system and make the experiment of the global file system.	1) Build the demo of cross-AZ file system and give out the test data 2) Build the demo of global file system and make the experiment of	File system demo and experiments data.

				the global file system.	

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HIRPO2017040602: Storage System Data Corruption Prevention

1 Theme: Storage Technology

2 Subject: Data Protection

List of Abbreviations

NA

3 Background

Achieving high data availability is one of main challenges in storage system, users always expects to get correct data from the storage system once data stored succeeded, but unfortunately, user/meta data will be corrupted/lost if we don't handle the issues occurred in the real world.

According to the research from academic and industry, the main issues causing data corrupted or lost include：

- Software Bugs

  File system, RAID layer, device drivers, metadata manage module, etc.

- Firmware Bugs

  Disk drivers, SAS card, GE card, etc.

The research also shows that these bugs are hard to be found via testing, in the meanwhile, the current reliability enhancing technology mainly focus on handling crash or hardware fault and recovery other than online fault tolerance caused by bugs or random memory corruption.

In order to reduce data loss or down time caused by metadata recovery, we wish to gain leading edge technology in bugs or random memory corruption prevention field via cooperation.

4 Scope

Problem to be resolved:

How to avoid data loss or metadata corrupted by bugs or random memory corruption

Three aspects research will be included:

1. Avoid user data loss

- Two types of host data: Block and file.
- Two corruption issues should be covered at least: Bugs and random memory corruption
- Avoid user data loss
- Performance influence should be less than 1%

2. Avoid meta data consistency error (CRC error)

- Two types of metadata : file system's meta data, raid 2.0 layer's meta data
- Two corruption issues should be covered at least: Bugs and random memory corruption
- Avoid corrupted metadata persisted to disk
- Performance influence should be less than 1%

3. Avoid metadata semantic error

- Two types of metadata : file system's meta data, raid 2.0 layer's meta data
- One corruption issues should be covered at least: bugs caused by semantic damage, that is, CRC is correct, but the relationship between multiple metadata is not correct, such as SSD FTL garbage collection, the wrong release of the data block is being used; repeat block write reference Increase and so on..
- Performance influence should be less than 1%
- Independent from function code, it is flexible to add/remove rules and handling strategy as necessary.

5 Expected Outcome and Deliverables

1. Design document
   - Including key technology principles
   - Including the key processing flow graph
   - Including the feasibility analysis
   - Including prevention technology description of each corruption issue

2. Demo code and testing report
   - Demo code based on BTRFS and F2FS
   - Demo code could be complied and executed
   - Auto test cases
   - Performance/Function test report based on demo code

3. Patent IDEA
   - At least two patents，reviewed and passed by HUAWEI

6 Acceptance Criteria

1. Detail Design Documents
   - Clear description of key technology, and resolve the problems listed in the requirement (including performance issue).
   - The key technology flow graph, key steps/data structures description

2. Demo Code
   - Demo code based on BTRFS and F2FS
   - Demo code could be complied and executed, including the guide document.
   - Document of key modification location and content

3. Test Report of demo code
   - Including auto test cases suites and results.
   - Including test result of issues raised in the requirement.

- Including the test result of performance influence.
- The test report matches design document.

4. Patent IDEA

- At least two patents

7 Phased Project Plan

Expected project Duration (year): 1 year

Project Phase	Start time	End time	Work content	work goals	Output
Phase 1	T	T+3	Avoid user data loss technology research	Performance influence should be less than 1%	Performance/Function test report based on demo code
Phase 2	T+3	T+7	Avoid metadata CRC error technology research	Performance influence should be less than 1%	Performance/Function test report based on demo code
Phase 3	T+7	T+12	Avoid metadata semantic error	Performance influence should be less than 1%	Performance/Function test report based on demo code

			technolog y research		

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HIRPO2017040603: Detect File System Invalid Data Technology

1 Theme: Storage Technology

2 Subject: Data Protection

List of Abbreviations

VM：Virtual Machine

OS: Operating System

DeDupe：Data compression technology that eliminate duplicated data in same data set

LBA: Logical Block Address

NTFS: New Technology File System, a Microsoft file system

3 Background

For modern data protection, VM is backed up with agentless technology that backs up VM's volumes with block level backup. With this mode, all data on volume will be read and saved that includes OS memory swap file, hibernation file, deleted file content. These files not only occupy more backup storage space, but also increase backup window and replication window. It also means that backup/restore efficient drops down.

When the backup data is replicated to other region, it not only consumes more CPU and network bandwidth, but also occupies more secondary backup storage space.

4 Scope

Problem to be resolved:

1. Detect VM's file system type with block level backup data.
2. Identify invalid data on file system (volume). For example, find out LBA array of pagefile.sys or Hiberfi.sys on Windows NTFS. Find out deleted file content's LBA.
3. Apply above technologies to VM block level volume backup process. During the backup, no code should inject into guest OS and popular OS should be supported.

5 Expected Outcome and Deliverables

1. Design document about architecture and details design. These document should describe overall architecture, modules, interoperation along modules clearly. The document should include not limit for logical architecture diagram, sequence diagram, process diagram. The document should include reliability and security.
2. Prototype code and test report. Code should be organized in clear structure with proper comments. Code should be kept consistent with design document. The prototype code can be domed to detect invalid data block on volume. The performance should be better than 2GB/s for invalid data.
3. 2 patens idea

6 Acceptance Criteria

- Design document should describe architecture, technology clear. Huawei expert can understand in one day. Huawei expert accepts the design and technology is correct.

- Prototype code can be compiled in Huawei compile environment and run well on test Huawei environment base on test report and test instruct. Code should be passed at Huawei export review and accept.
- 2 patens idea pass Huawei paten review committee.

7 Phased Project Plan

Expected project Duration (year): one year

Project Phase	Start time	End time	Work content	work goals	Output
Phase 1	T	T+1	1. Reach an agreement on requirements, deliverables and acceptance criteria 2. Reach an agreement on design ideas.	1. Determine requirements and acceptance criteria. 2. Reach an agreement on design ideas	Memorandum of requirements and acceptance criteria. 2. HLD design document
Phase 2	T+1	T+7	LLD design and technology development	Finish LLD design and technology development	LLD design document and prototype code
Phase 3	T+7	T+12	Prototype internal validation and	Meet requirements and delivery	1. Updated design documents

			tuning	standards	and prototype code. 2. Test report.

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HIRPO2017040604: Storage Device (DIMM and HDD) Reliability Improvement

1 Theme: Storage Technology

2 Subject: Storage Device (DIMM and HDD)

List of Abbreviations

NPR: Number of Problem Reports

HDD: Hard Disk Drive

DIMM: dual in-line memory module

3 Background

In all NPRs (Number of Problem Reports), HDD and DIMM have the maximum number of failures among the hardware devices. In 2017, the overall hard drive failure prediction will be raised to 90%, reaching commercial standards. In the scene of DIMM design, DIMM production test and the DIMM running, we face these problems that the failure is not reproduced, the alarm threshold is difficult to determine and the low efficiency of the screening algorithm, because we don’t know the typical failure mode, cannot take targeted design and reliability assessment.

4 Scope

Problem to be resolved:

1) HDD：

HDD failure prediction accuracy rate up to 90%, false detection rate below

0.5%

2) DIMM:

- the typical failure mechanism (Cell, contact, curing) and detection algorithms and laws
- Research on Memory Failure not reappearing, including Failure Mechanism and Life Risk.

5 Expected Outcome and Deliverables

NO.	Expected Outcome	Expected Deliverables
1	HDD failure prediction	HDD prediction algorithm
2	DIMM failure mode	DIMM failure mode and test algorithm
3	Research on Memory Failure not reappearing	The report focuses on Memory Failure not reappearing.

6 Acceptance Criteria

1) HDD prediction algorithm: failure prediction accuracy rate up to 90%, false detection rate below 0.5%.

2) DIMM failure mode and test algorithm: the typical failure mechanism (Cell, contact, curing) and detection algorithms and rules.

3) The report focuses on Memory Failure not reappearing: memory Failure not reappearing, including Failure Mechanism and Life Risk.

7 Phased Project Plan

Expected project Duration (year): 1 year

Project Phase	Start Time	End time	Content	Objective	Output
Phase 1	T	T+3	Complete the feasibility of the program analysis	set a strategy	Submit the program document
Phase 2	T+4	T+8	Data collation, joint verification	Determine the failure mode and algorithm, prototype development	algorithm /failure mode
Phase 3	T+9	T+12	Input data, algorithm validation	Verification of program validity	Applicable solutions

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