MobilityFirst FIA Internet Architecture: Overview

MobilityFirst Workshop

Organized as a part of:
Project: Engaging undergraduates in research that speaks their language
Sponsoring Agency: The Thurgood Marshall College Fund
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Slides based on: MobilityFirst: a robust and trustworthy mobility-centric architecture for the future internet, D. Raychaudhuri, K. Nagaraja and A. Venkataramani, ACM SIGMOBILE Mobile Computing and Communications Review

Overview

1. MobilityFirst Future Internet Architecture: Vision
2. The MobilityFirst Architecture
3. MobilityFirst Names and Addresses
4. MobilityFirst Names and Addresses
5. MobilityFirst name based network API and hybrid name/address based routing
6. Protocol building blocks in MobilityFirst
7. MobilityFirst packet processing, routing and transport
8. MobilityFirst: A pictorial journey into the features of a MobilityFirst router
9. Conclusion and Homework
10. Final report topics

The MobilityFirst project: Goals and Motivation

MobilityFirst is one of the 5 projects funded by the National Science Fund in 2010.[1] This project builds upon the vision that mobile platforms and applications will replace the fixed host and server models. The focus is on designing a trustworthy Internet that supports content and mobility as the first class citizens.

1. Seamless host and network mobility: Mobility and wireless hosts should be considered as a norm rather than an exception
2. The architecture should not require a single global root of trust.
3. Receivers should have the ability to control incoming traffic and refuse unwanted traffichosted location
4. If a small number of nodes are compromised, they should not be able to deliver a wide impact on the performance of the network
5. The network should be able to address content independent of its location
6. The architecture should allow deployment of new services

[1] http://www.winlab.rutgers.edu/pub/docs/focus/MobilityFirst.html

Why should Mobility come first?

It is really very obvious, but lets still do the numbers...

1. There are over 6 billion cellular mobile devices world-wide in use today: Mobile data devices are significantly outnumber fixed hosts
2. In 2014, mobile data traffic will surpass traffic from fixed stations
3. In 2016, 61% of IP traffic will be due to wireless and mobile devices
4. Follow the Cisco whitepaper on Visual Networking Index for more[2]

The "Mobile Internet" is emerging can the IP based network architecture handle it?

[2] http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html

Why should Mobility come first?

Convergence of Cellular Networks and the Internet...

- Mobility is driving the convergence of two completely different networks - circuit switched and packet switched
- Challenge is to unify the two networks that support billions of mobiles in a trustworthy manner
- Furthermore, in 5 years $\tilde{2}020$, the network needs to deal with M2M, smart grid, V2V and other physical world aware devices into the Internet application

MobilityFirst: The Vision

Clean-slate redesign of the Internet with the goal of not just "fixing" IP to add security and mobility...

1. Support mobile devices as first class objects without the need of cellular gateways or overlays
2. Security, privacy and trustworthiness must be built into the network design
3. New services such as disconnection tolerant applications, content caching and context awareness should be supported seamlessly and at scale

MobilityFirst: The Architecture

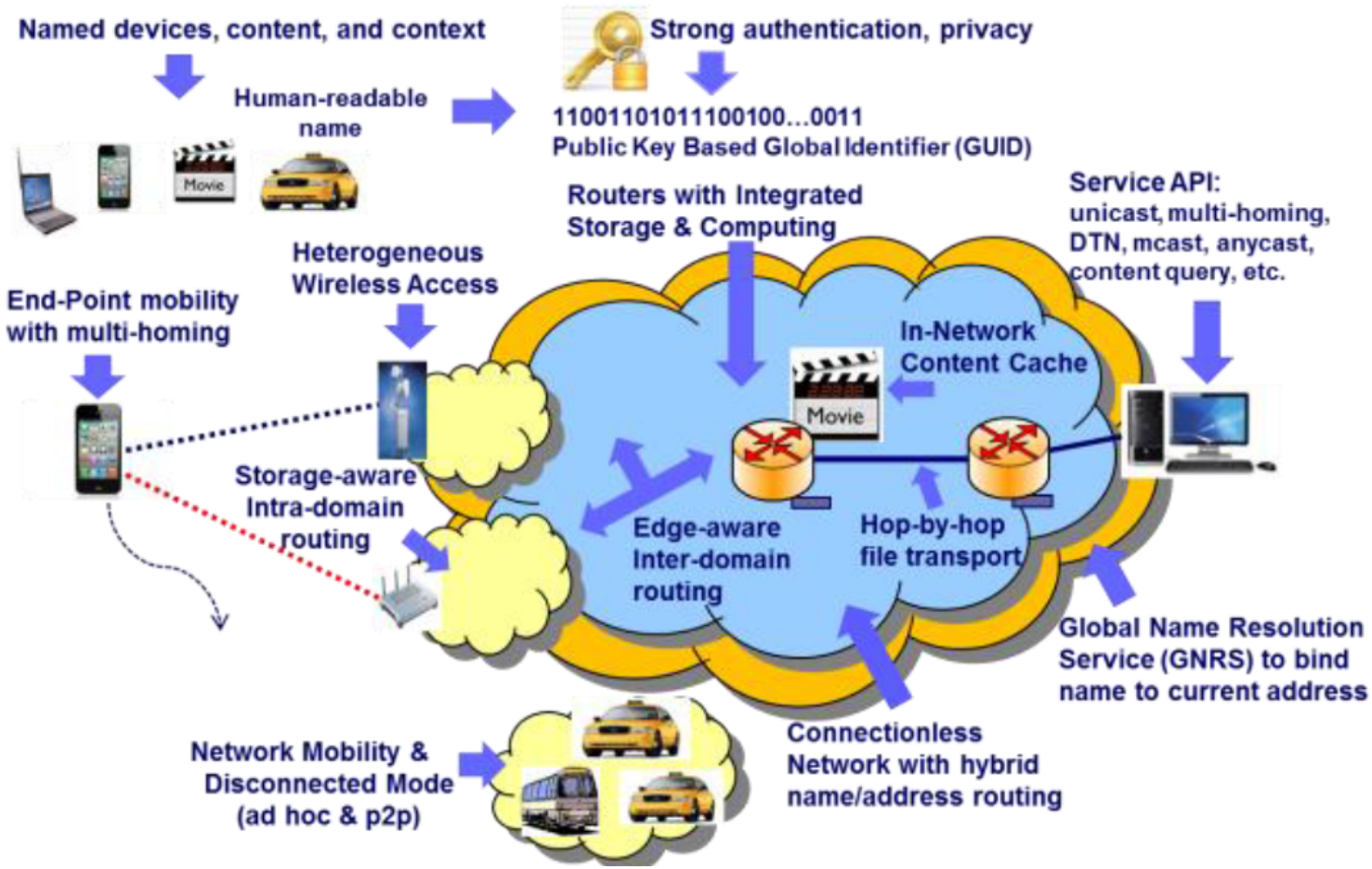

Figure: The MobilityFirst architecture features. *Image Source:*[3]

[3] See paper cited on the title slide

The Architecture Concepts

A name based service layer serves as the "narrow waist" of the protocol stack.

Flat globally unique identifiers (GUID) used to name all network objects

- GUIDs are public keys assigned by a name certification service
- They are long lasting, network level names for objects. GUIDs persist even when the objects move around in the network
- Network messages contain source and destination GUIDs to identify the communication parties
- GUIDs may also refer to services and content, support multicast and multihoming

The Architecture Concepts

Hybrid name/address based scheme is used for scalability,

- A fast global name resolution service (GNRS) binds destination GUID to a current set of network addresses where the destination is attached
- As the object moves around, the destination network address in the message keeps getting updated
- In order to improve efficiency, the architecture uses late-binding to network addresses i.e., the actual network address to the message is assigned when the message gets closer to the destination.

MobilityFirst Names and Addresses

Separation of Names from Addresses

Three different names/addresses: Each separate and independent and yet tied together at some level...

1. Human readable names
2. Network names (GUIDs)
3. Network address locators (NA)

How are addresses assigned/resolved?

- Human readable names are assigned to GUIDs by any name certification service (NCS) (not necessarily a centralized ICANN)
- GUID space, being very large, no coordination among NCSs is needed.
- *NCS can convert a GUID to its human readable name and vice-versa*
- GNRS provides the network address of objects named by the GUID

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Network API and Routing

Name based socket API

The socket like API in MobilityFirst uses source and destination network names

When writing an application, the programmer binds the socket to a network name (GUID), instead of an address (like IP address)

The underlying service that delivers messages is inherently multicast, due to the assumption of mobility and the fact that mobile devices, by default, have several network interfaces.

Hybrid Name/Address based routing

The total number of GUIDs are expected to be $\tilde{1}$0-100 billion

Number of globally routable networks are expected to be in order of millions

Task of mapping GUID to NA is hard, since it needs to be very fast

This question has not been fully answered for an Internet scale network

Other architectural components

- Mobile end-points with multi-homing
- Network mobility, ad-hoc and disconnected modes
- Hop-by-Hop transport
- In-network computing services

Basic building blocks that make up MFirst

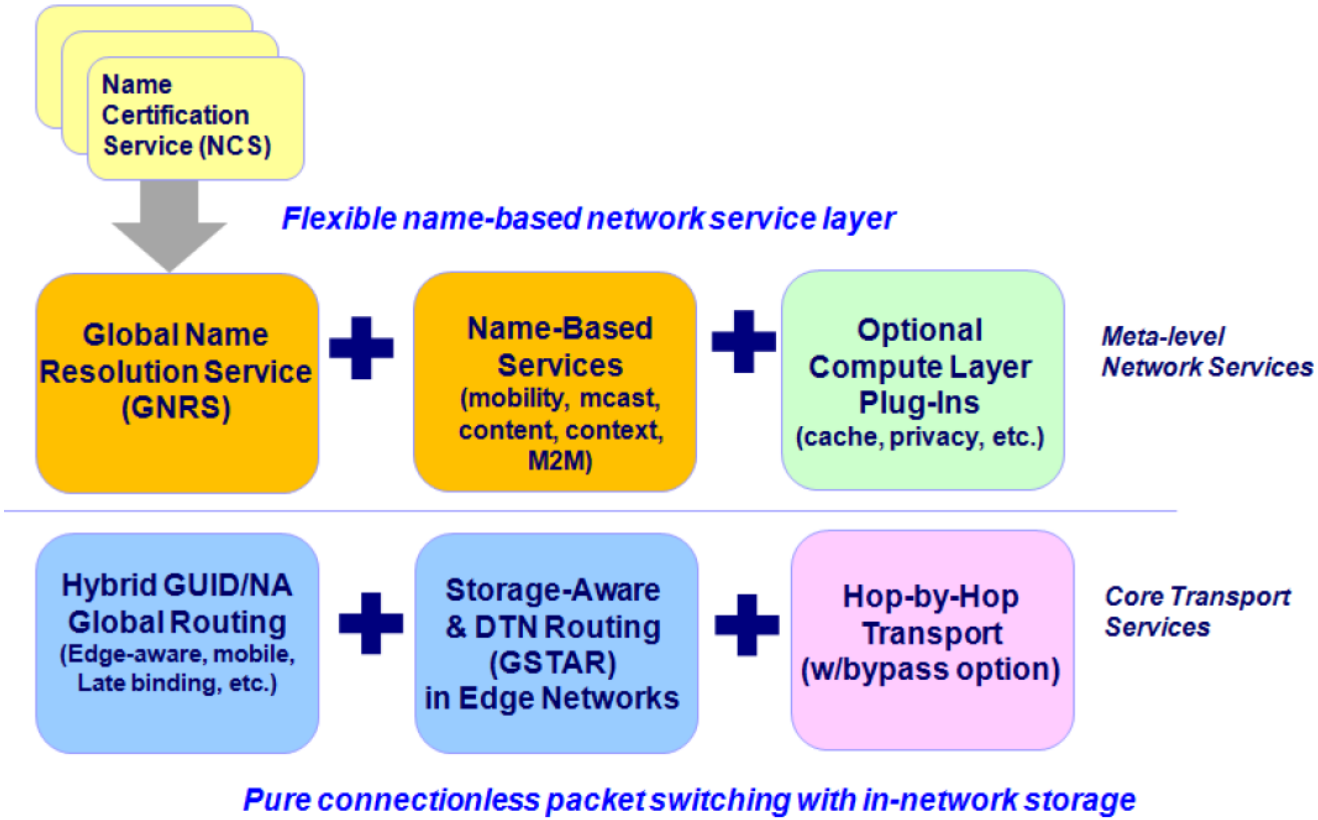

Figure: Protocols that realize the MFirst vision. *Image Source:*[4]

[4] See paper cited on the title page

Hybrid GUID/NA packet processing at routers

Two routing tables at each router:

GUID to NA table

- Maps GUID's to network addresses
- Constructed as a distributed hash table (DHT), different routers responsible to maintain different sets of mappings
- Router may use the table or may use GNRS to re-resolve GUID to NAs
- implements late binding of names and addresses

Network Address to Next hop table

- Maps NA to the routers interface where the message should be forwarded
- Constructed using storage aware routing in edge networks and inter-domain routing in the core.
- If a router does not know how to reach a GUID, it may temporarily store messages for that GUID until a route is found!

MobilityFirst router: Packet processing

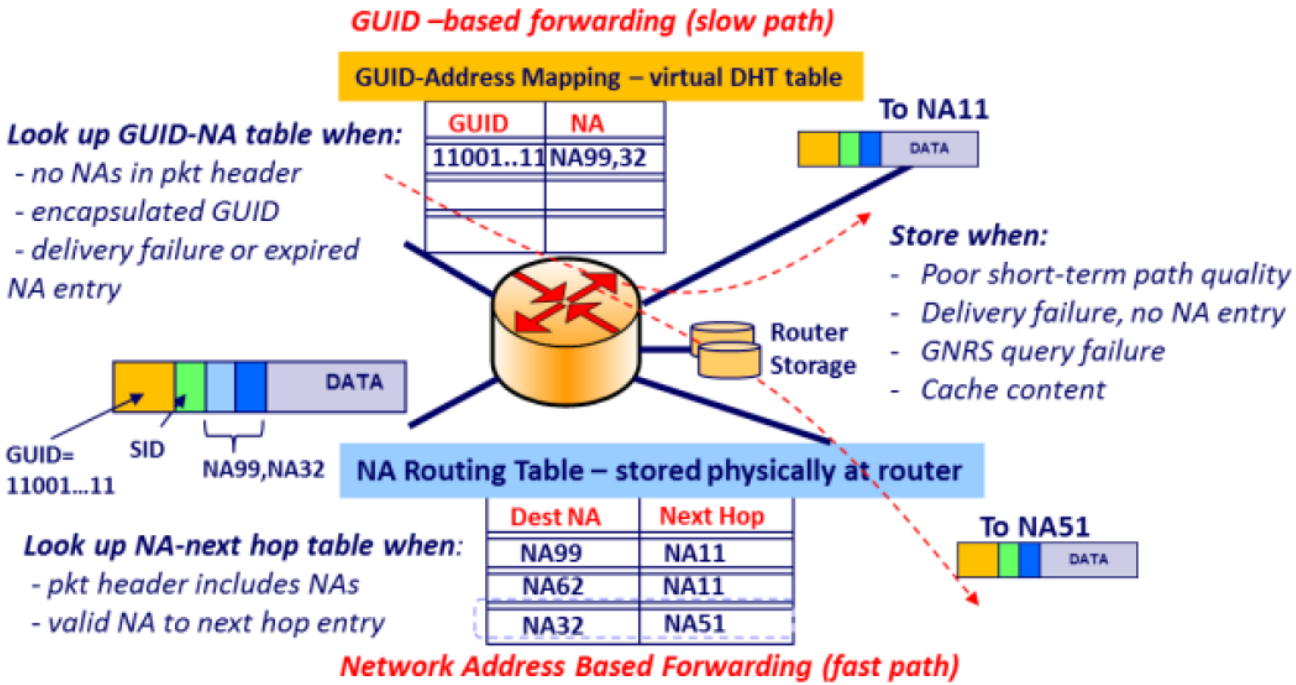

Figure: Packet processing in a MobilityFirst Router: *Image Source:*[5]

[5] See paper cited on the title page

MobilityFirst router: Multihoming

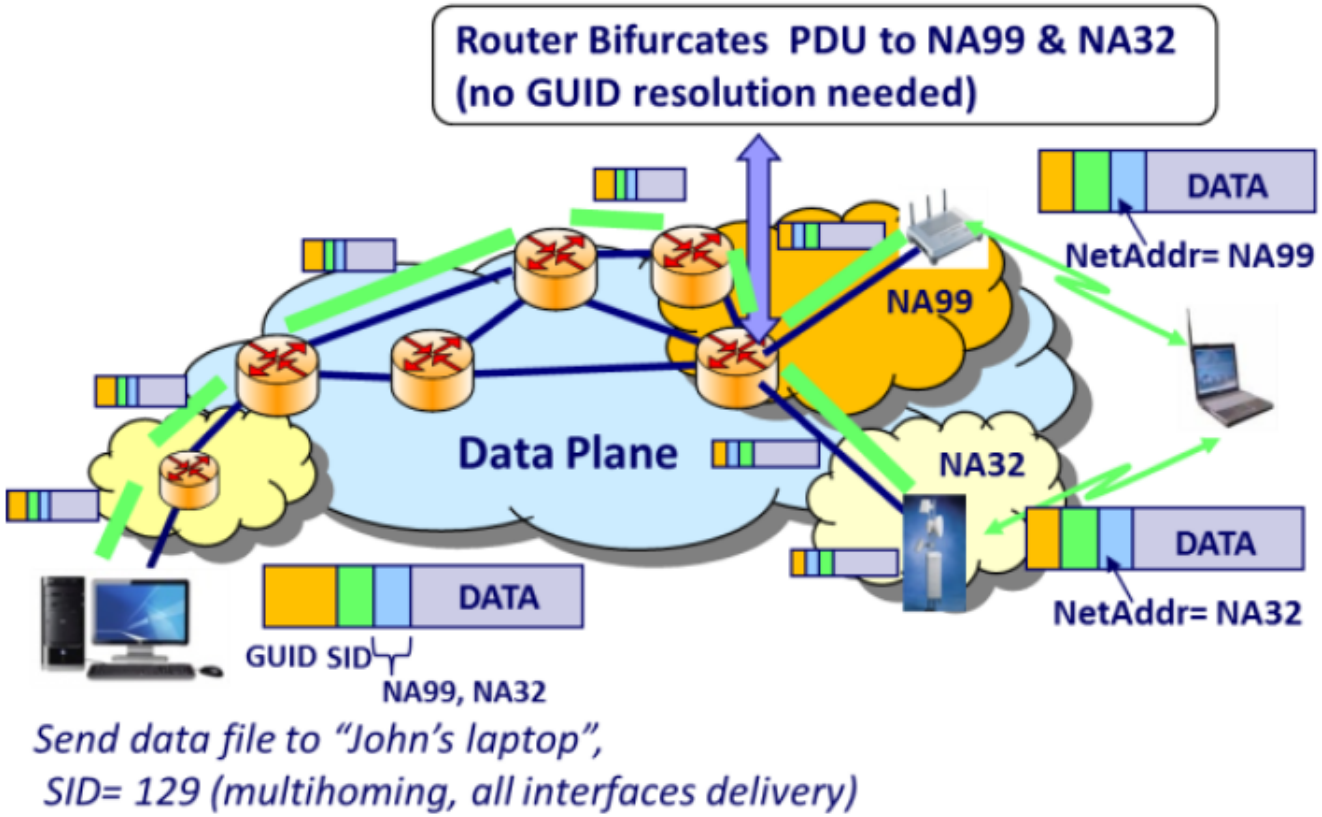

Figure: Multihoming to deliver data to a destination: *Image Source:*[6]

[6] See paper cited on the title page

MobilityFirst router: Disconnection

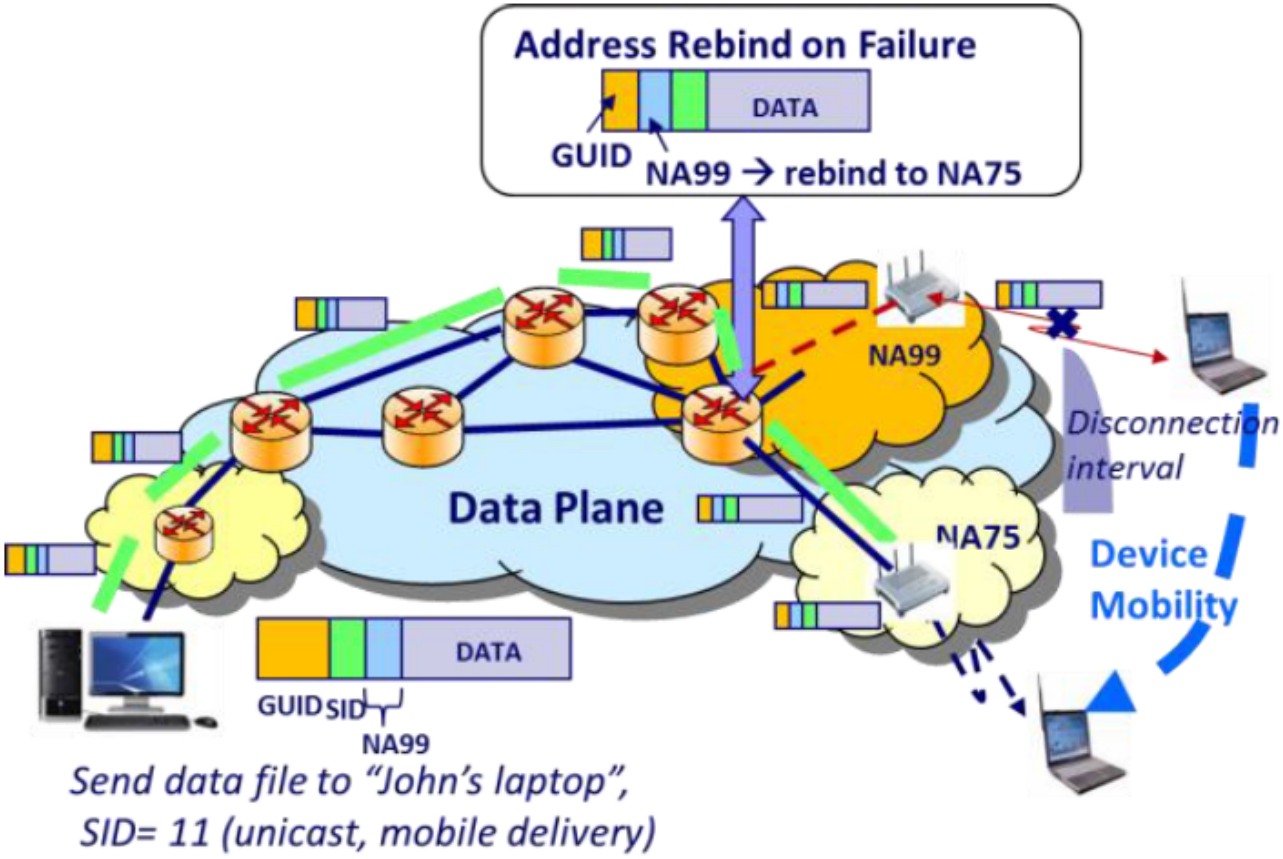

Figure: Data delivery when the destination disconnects and moves away!: *Image Source:*[8]

[7] See paper cited on the title page
[8] See paper cited on the title page

Comments or Questions?

Homework

Read the paper that was summarized in this slide
Blog about what you like, dislike or think about the paper and this presentation

Resources

- MobilityFirst website `http://winlab.rutgers.edu/docs/focus/MobilityFirst.html`
- Generalized Storage Aware Routing `http://mobilityfirst.winlab.rutgers.edu/documents/GSTAR-MobiArch11.pdf` `http://www.computer.org/csdl/proceedings/wowmom/2011/0352/00/05986209-abs.html`
- The MobilityFirst Proof-of-Concept implementation `http://winlab.rutgers.edu/docs/focus/POC.html`
- The Global Name Resolution Service `http://winlab.rutgers.edu/docs/focus/documents/GNRS_ICDCS2012_Vu.pdf`

Final reports

All participants must choose a final report title.
The report must be around 1,000 words long, may contain pictures
You should choose a sub-topic from the slides covered thus far
Reports are required for evaluation and acceptance in the second phase of this project that runs from September to end of November