Introduction to Content Centric Networking

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FISS 09
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This talk describes ongoing PARC work on CCN (Content-centric Networking) by:

- Jim Thornton
- Diana Smetters
- Nick Briggs
- Michael Plass
- Rebecca Braynard
- Elaine Shi
- Simon Barber
- Ignacio Solis
- Mark Mosko
- JJ Garcia-Luna
- and me

CCN goals

Create a simple, universal, flexible communication architecture that:

- Matches today's communication problems
- Matches today's application design patterns
- Is at least as scalable & efficient as TCP/IP
- Is much more secure
- Requires far less configuration

Universal?

- Any architecture designed to run over anything is necessarily an overlay.
- What matters are capabilities: IP started as an overlay on the phone system; today the phone system is an overlay on IP ... IP has a universality independent of any layer-2.
- CCN has the same character: it can run over anything, including IP, and anything can run over CCN, including IP.

Talk Plan

- History and motivation
- Content Model
- Security Model
- Node Model
- Routing
- Transport

Networking was invented in this world

Networking was invented in this world

It was about sharing resources,
not data.

Networking created today's world of content but was never designed for it

- The central abstraction is a host identifier.

- The fundamental communication model is a point-to-point conversation between two hosts.

Unfortunate consequences

- Networking hates wireless, mobility and intermittent connectivity.

- Cognitive mismatch - user/app model is *'what'*, network wants *'who'*. Mapping between models requires a lot of convention and configuration (middleware & wetware).

- No useful security - content is opaque to the net and it can't secure something it knows nothing about.

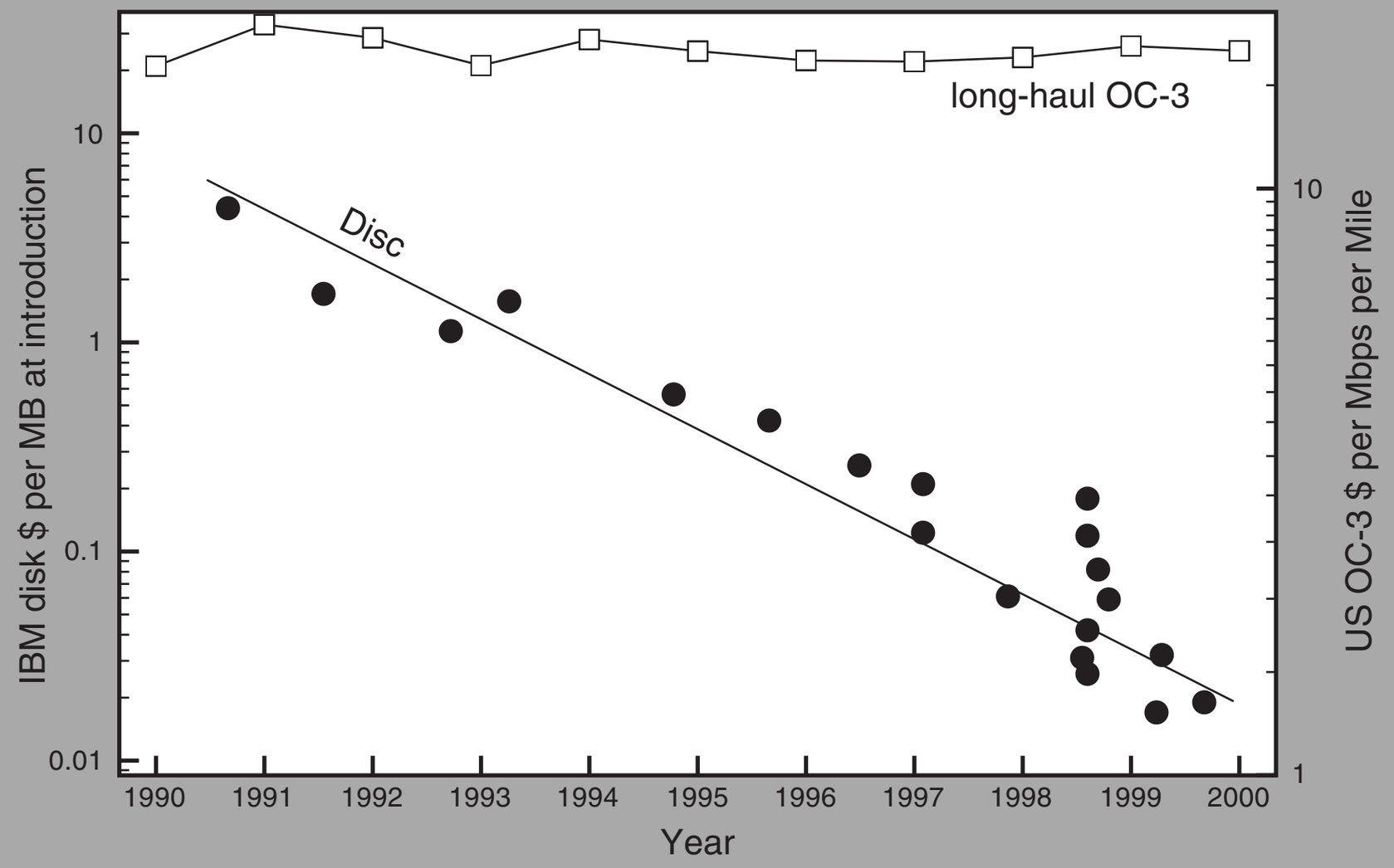
Data Communications today is about moving content

- There is a lot of content: As of Dec 2008 the Internet was moving 8 Exabytes/month.
- IDC reports that 180 Exabytes of new content was created in 2006.
- More than a Zettabyte is expected in 2010 (60% annual growth).

Andrew Odlyzko, UMN, Minnesota Internet Traffic Studies (MINTS)

John Gantz, IDC (March, 2008). "An Updated Forecast of Worldwide Information Growth Through 2011".

Networking & storage cost evolution



Disk: D. Thompson, IBM JR&D, May 2000

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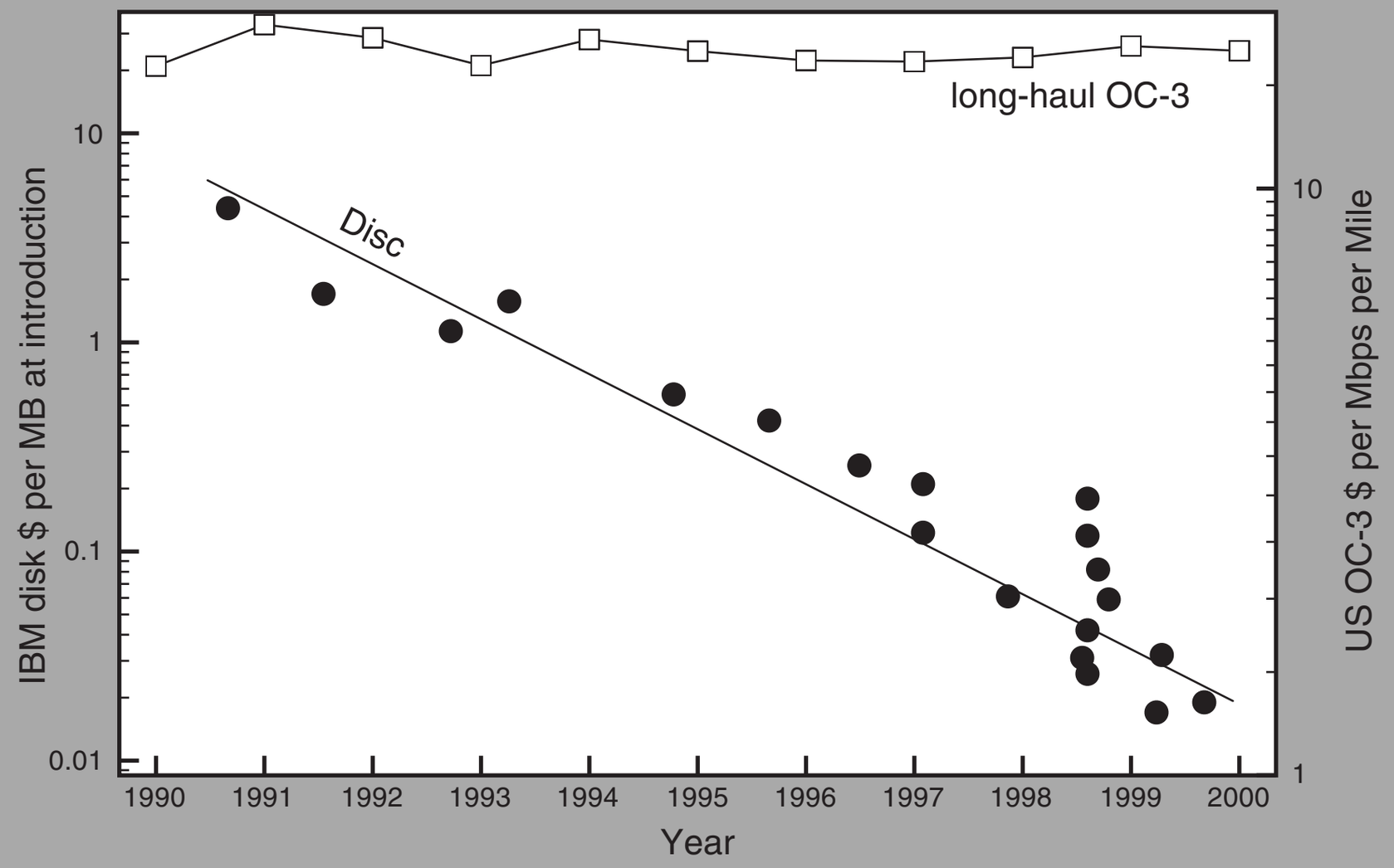

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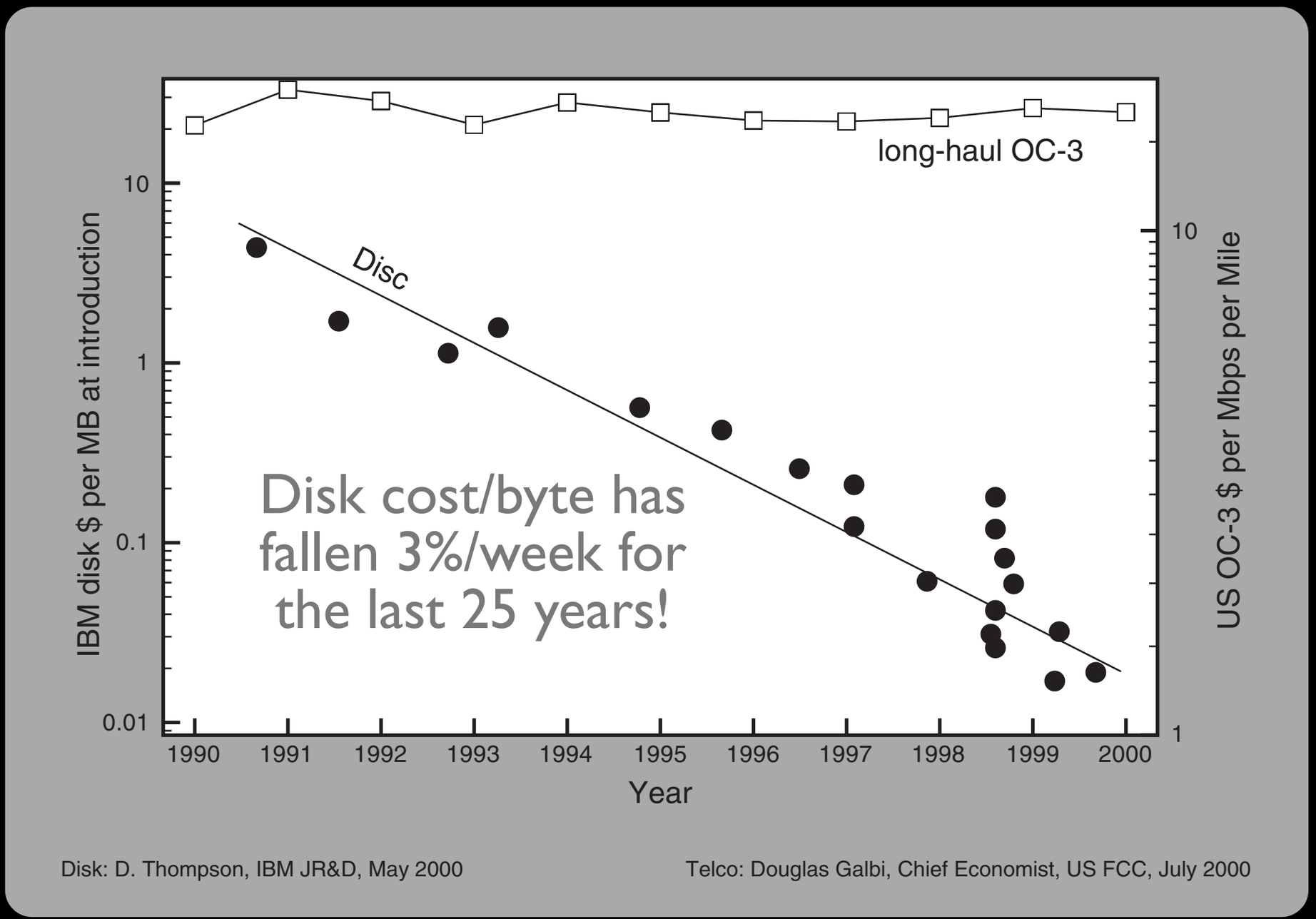

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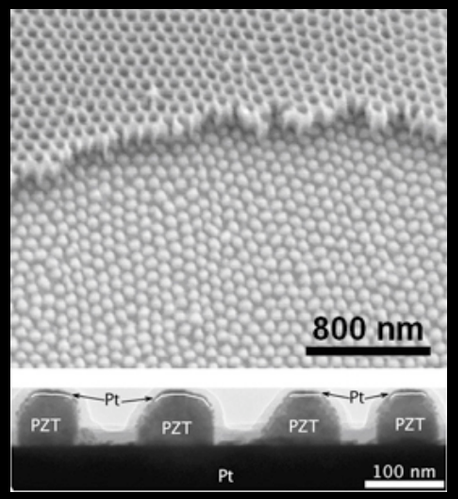
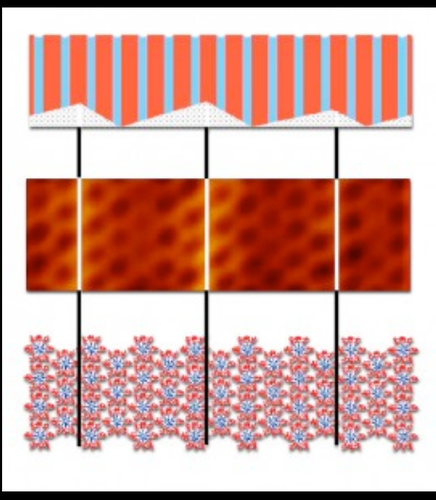
and storage is going to get a lot cheaper ...



200 Gb/in^2 PZT nano-capacitor non-volatile memory

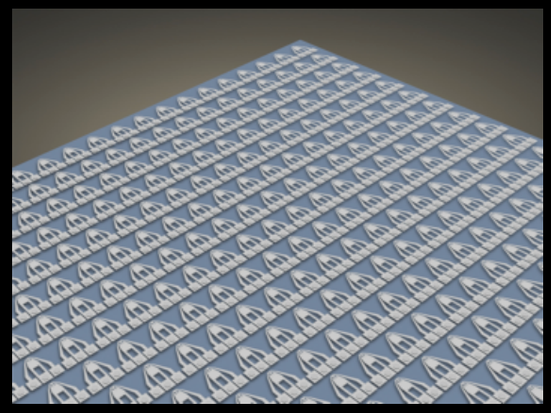
Max Planck Institute, June 2008

10 Tb/in^2 co-polymer magnetic memory

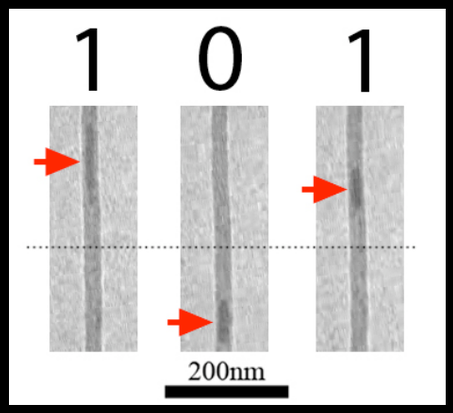


LBL, Feb. 2009

4 Tb/in^2 MEMS memory array



Univ. Twente, July 2009



LBL, May 2009

Tb/in^2 carbon nanotube magnetic memory

Cost evolution favors trading storage for bandwidth but ...

Storage names say what we want,
Network names say who we want.

Mapping between these two models requires a lot of plumbing (middleware & wetware).

Can we create a network architecture based on named data instead of named hosts?

Making content move itself

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- Devices express 'interest' in data collections.

- Devices with data in collection respond.

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- Devices express 'interest' in data collections.

- Devices with data in collection respond.

- Users specify the objective, not how to accomplish it.
- Data appears wherever it needs to be.
- Model loves wireless and broadcast (802.11, RFID, Bluetooth, NFC, ...).
- There's no distinction between bits in a memory and bits in a wire.
- Data security and integrity are the architectural foundation, not an add-on.

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Self-managing information needs *context*

- *Ontology* (the relationship of this to other information)
- *Provenance* (some basis for trust in the information)
- *Locality* (proximity awareness and management)

Friction

Moving up-level is an amplifier.

- *We shouldn't amplify mistakes.* (E.g., if you accidentally delete a file anywhere, FolderShare makes sure it's deleted everywhere.)

- *We shouldn't amplify attacks.* (Machines need a very high level of confidence in context & data integrity).