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Research on a MIP-based scheme providing reliable yet economical Intranet connectivity

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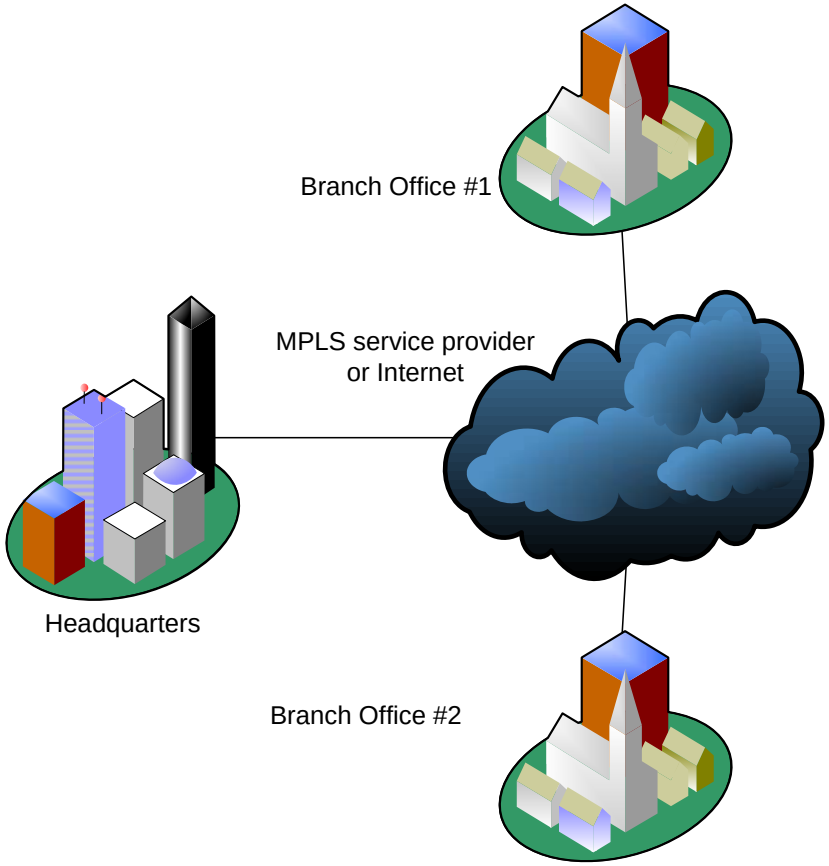
Problem statement and motivation

- Organization has headquarters and some branch offices
- Suppose organization needs intra-site connectivity with high reliability
- Some options:
  - Dedicated lines/connections with redundancy guarantees and Service Level Agreements
    - Very expensive
  - Multihoming via several providers with routing protocols
    - Switchovers far from immediate
    - Harder to maintain
  - Multihoming over Internet using VPNs
    - Mgmt & Configuration issues
    - Or central chokepoint

➔ Usually very expensive in either monetary and/or workload terms



Economical version – Idea:

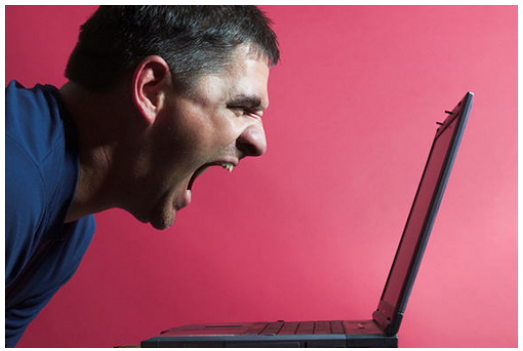
- Cheap Internet access: Consumer-grade Internet connections
- Standard consumer Internet connection usually works ”most of the time”
  - But no guarantees are given
  - May break down several times a day or for extended periods without any warning whatsoever
- Solution: Bundle several such consumer connections together
  - On the assumption that they have e.g. 2 % average downtime each:
  - 3 connections = 0,0008% downtime ➔ 99,9992% uptime, ”five-nines” reliability
- Technology approach chosen: Mobile IP with additional extensions
- Requires NO changes to existing end-user terminals
- Uses existing infrastructure, immediately deployable

Key issue of ANY network: End-user experience

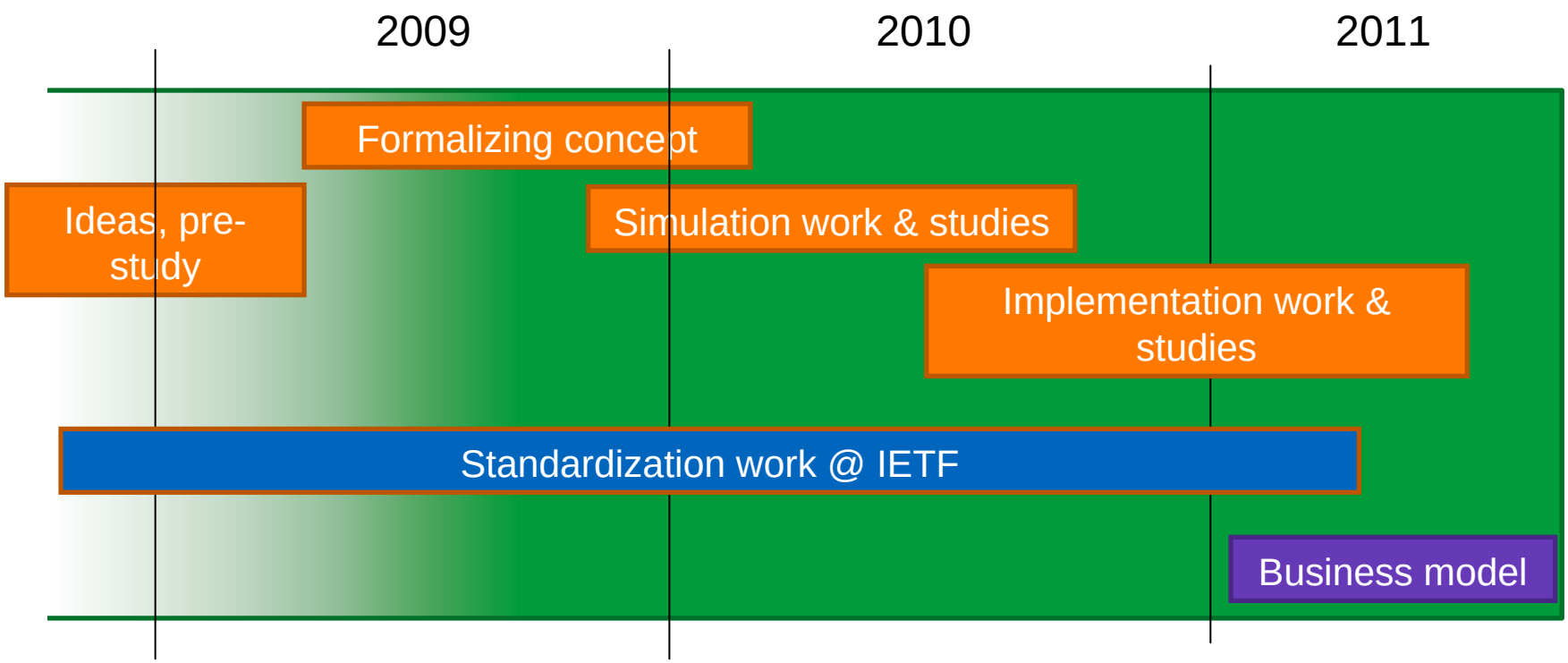
- Network's usability during failure conditions, end-user perspective is paramount
- There should never be a perception "Nothing is happening"
- Usability requirements vary depending on application – but solution should work with all of these:
  - "Bulk": E-mail, downloads, etc: Short pauses have no practical effect
  - "Interactive": Web browsing: 1-2 second pauses tolerated
  - VoIP and realtime applications: Few hundred milliseconds are tolerable

➔ Whatever the network does must be transparent

➔ In our case switchovers must be immediate



Timeline throughout FI SHOK Phase 2



Timeline, more detail

- Pre-study and idea formation phase, pre-2009
- Included in FI ICT SHOK for 2009-2010 term, continued in phase 3
- Concept has been presented at ACM SAC 2010 conference
- Technology research
  - Simulation work to be presented in PAMS 2011 conference
  - Implementation work submitted to IPCC 2011 conference, acceptance pending
  - Standardization work in IETF – draft closing on WGLC
- Business model study in phase 3

Simulation work

- Utilizes ns-3 network simulator
- Benefits of ns-3
  - Can be configured to use real-world TCP/IP stacks (not some ”ideal” model)
  - Additional components can be implemented to simulate any layer in OSI stack from link to application
- Mobile IP with Network Mobility and Route optimization implemented
- Checked feasibility of technology and effect on interactive applications (TCP-based, web-browsing)
- Additional enhancements with simple load balancing algorithm for maximum utilization

Implementation

- Implementation – prototyping-grade code and hardware
- Could be a basis for a real product (if a vendor chooses to go for it)
- …and experiments keep showing that approach is feasible
- Evaluation conducted using Spirent's industry-standard testing platform

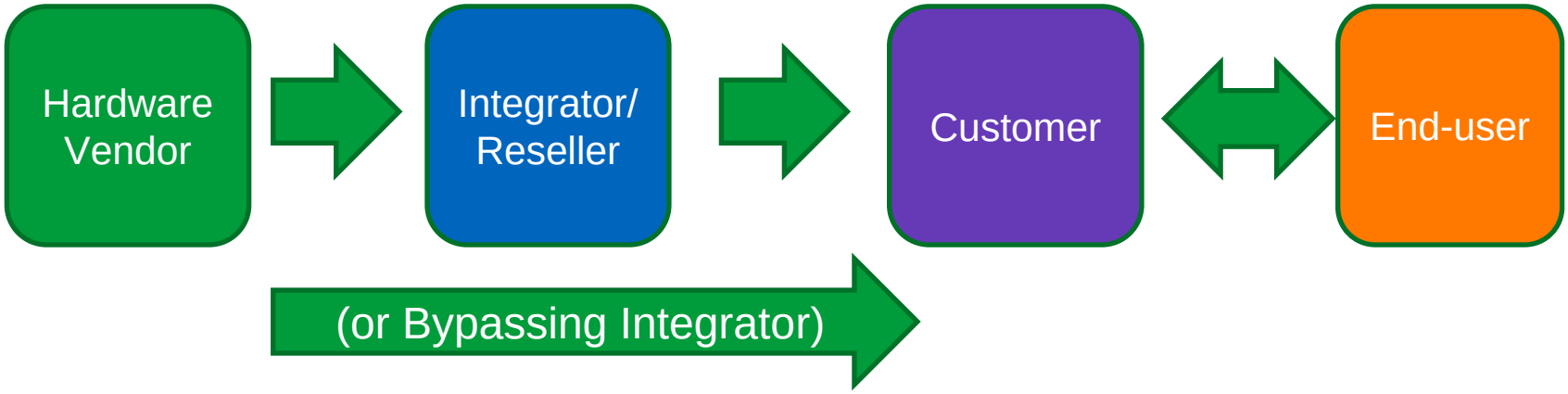
Implementation details

- Based on Dynamics Mobile IP stack, originally developed at TKK circa 2002
  - GPL-licensed, open source
- Heavily amended to support
  - UDP encapsulation
  - Network Mobility
  - Route Optimization
- Deployed on Alix PC system boards
  - AMD Geode CPUs
  - Debian Linux

Future: Business feasibility analysis

- The Question: Can you offer a service, where you provide a single, virtual, high-reliablity bit-pipe over several unreliable connections
  - …and actually set service level guarantees on it (= Bet that customer won't experience enough issues to warrant sanction payments)
- The approach competes with traditional service providers yet may be using their infrastructure – clear conflict of interest
- Will probably not be sold as "off-the-shelf" boxes directly to end-customer
  - Unless they have required competence
  - Device vendor ➔ Reseller/Integrator ➔ Customer
  - Integrator responsible for avoiding pitfalls such as shared physical links

Business model, players diagram



Summary

- Technology approach to provide economical, guaranteed Intranet connectivity
- Most important factor: End-user experience
- Simulation results very promising
- Full implementation has so far validated simulation results
- Business model study forthcoming

Thank you

- Questions & Comments?