S-38.3215 Special Course on Networking Technology

Fall 2005

Kalevi Kilkki
Principal Scientist, Nokia
Docent, TKK

Critical thinking

To develop systematic skills in critical thinking about communication networks and services

Course content

- Lessons 2 * 3 hours
  - 9.11. Intro, some tools
  - 16.11. Selection of topics for group work
    - Some thoughts about ATM & 3G
      - "history"
      - different perspectives
      - network evolution
  - 30.11. Presentations & discussion
  - 7.12. Presentations & conclusion
  - x.12. Examination or "controlled exercise"

Other issues

- Assistant
  - Timo Smura timo.smura@tkk.fi
- ECTSs and grade depend on
  - Presentation (~60%)
    - min: slides
    - target: paper submission
  - Final examination (~40%)
  - Course activity (may improve by 1)
- Any other issue?

Possible topics for critical evaluation

- Networks
  - Ad-hoc
  - Sensor
  - 4G
  - ...
- Services
  - Mobile TV
  - Mobile music
  - PoC
  - ...
- Tools / Methods
  - Policy control
  - Optimization
  - ...

- (possible) Approach
  - Select some “typical”, non-critical papers about the topic
  - Make a brief analysis
    - Motivation and goal of the authors
    - Do they authors think themselves?
    - How they select and mix “facts” and opinions
    - etc.
  - Make an own critical, multi-perspective analysis

(Repetition) What to consider

- Business benefits
  - Operator decisions are business decisions
    - Market potential, business model
    - Cost factors
- User benefits
  - How often, in which situation, what additional value?
    - Simple, rough but illustrating assessment is often easy
- Different perspectives
  - Network, application, user, business
- Realistic network evolution
  - The size is of (final) gain is not the only issue (game theory)
- Lessons from history (see Odlyzko)

Lessons from the fate of ATM

“Asynchronous transfer mode, why and how”

- Carsten Rasmussen (Copenhagen Telephone Company)
  - NTS-9, 1990 (brief, typical, but still a reasonable article)
- Main alternative for ATM
  - Fiber to the home & optical switching
    - not in this century (< 2000)
- Need for broadband
  - Probably first for business sector
  - “If someone invents a service, that is really interesting for private users, the market could suddenly explode ... such as
    - Dial up your favorit Fellini
    - Get your grandchildren right into your living room, or
    - a multimedia encyclopedia where a subject is demostrated optimally on a combination of words, sound and interactive video”

Rasmussen and many others continue

- High quality video below 2 Mbit/s seems difficult
  - some services need more, some less
  - multiplexing several bit rates into the same network is necessary
- NOTE
  - Comparison only between circuit switching and ATM, without mentioning IP, why?
    - video, not data
    - business model (telecom)
- Rasmussen continues
  - "The network and the services are waiting for each other. Some one must take the decision to create large scale broadband network before real services will come."
- GSM became a success
  - but the need and service were already known (NMT)

Blind spots?

- Network service
  - Access vs. a point to point connection
  - Detailed control
- Business model
  - Flat rate vs. each connection paid separately
  - Detailed control
- User need
  - Underestimated
    - Text messaging (SMS, E-mail)
    - Free access to any information (Web)
  - Overestimated
    - Video
    - Technical requirements related to network service

Content

- See also Odlyzko, e.g.
  - http://firstmonday.org/issues/issue6_2/odlyzko
    - Content certainly has all the glamor.
    - What content does not have is money.
- US revenues, $ billions (1997)
  - Telephone industry 256
    - consumer spending on phone services 85
  - US postal 58
  - Advertising 187
  - Motion pictures 63
  - Television 37
  - Radio 13
  - Video rental & purchase 20
  - Recorded music 15

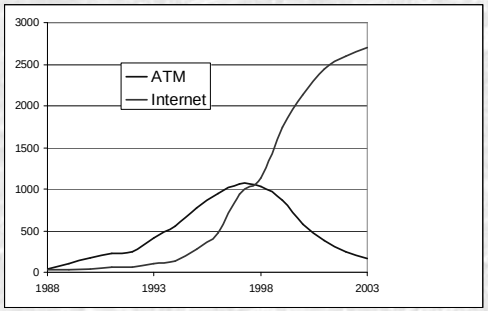
IP

- From telecom perspective, IP was very disruptive
  - always difficult to adopt by incumbents
  - Was IP in any way a realistic choice for Telecom operators before 1995?

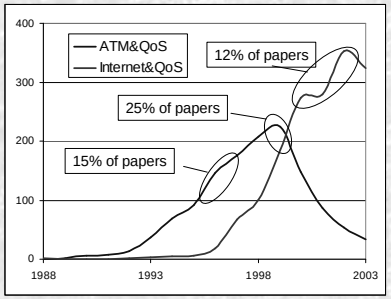
Process

- ATM development effort
  - HUGE...maybe 200 000 papers
    - abundant funding because of popularity
    - popular because of available funding
- Before any real life experience!
  - Always tend to lead to excessive complexity and control
  - Abundant resources expedite this process
- Real needs are often limited
  - ATM: network management (not consumer service)
  - maybe 90% of development toward wrong goal, even harmful

Papers / year (IEEE)



QoS in abstract

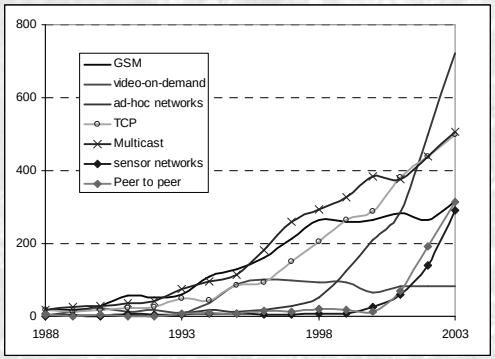


"Economic" in abstract (IEEE)

	ATM	Internet
1988	3	0
1989	3	0
1990	6	0
1991	2	1
1992	9	1
1993	8	0
1994	10	1
1995	7	2
1996	16	16
1997	17	22
1998	10	20
1999	10	30
2000	7	49
2001	3	40
2002	4	42
2003	4	36

ATM: 1.5%
Internet: 1.7%

Other papers/year (IEEE)



Core principles

"Sensible design principles for new networks and services"

- Development of a new technology must be based on core principles
- Core principles must be able to limit the innate trend toward complexity
- When a current technology is developed further
  - Look for methods and mechanisms that
    - serve both the interest of key stakeholders,
    - and the common good
  - Be critical with methods without clear motivation for key players
    - pure common good is, unfortunately, not enough

(ATM vs.) Internet

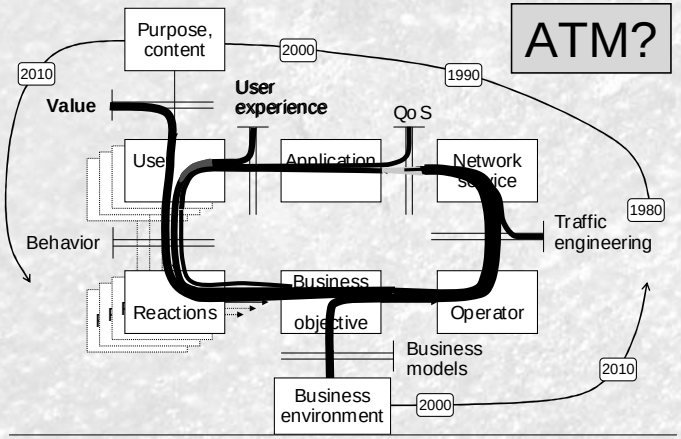
- RFC 1958 Architectural Principles of the Internet
  - Fortunately, nobody owns the Internet, there is no centralized control, and nobody can turn it off. Its evolution depends on rough consensus about technical proposals, and on running code. Engineering feed-back from real implementations is more important than any architectural principles.
- General Design Issues
  - 3.1 Heterogeneity is inevitable and must be supported by design.
  - 3.2 If there are several ways of doing the same thing, choose one. If a previous design has successfully solved the same problem, choose the same solution unless there is a good technical reason not to.
  - 3.3 All designs must scale readily to very many nodes per site and to many millions of sites.
  - 3.4 Performance and cost must be considered as well as functionality.
  - 3.5 Keep it simple.
  - 3.6 Modularity is good. If you can keep things separate, do so.

Internet design

- 3.7 In many cases it is better to adopt an almost complete solution now, rather than to wait until a perfect solution can be found.
- 3.8 Avoid options and parameters whenever possible.
- 3.9 Be strict when sending and tolerant when receiving.
- 3.10 Be parsimonious with unsolicited packets, especially multicasts and broadcasts.
- 3.11 Circular dependencies must be avoided.
- 3.12 Objects should be self describing (include type and size), within reasonable limits
- 3.13 All specifications should use the same terminology and notation, and the same bit- and byte-order convention.
- **3.14 And perhaps most important: Nothing gets standardised until there are multiple instances of running code.**

Perspectives

Perspective



Evolution

Methods and evolution

Methods that are beneficial

1a. only when all operators implement them, and the benefit is equal among all operators.

1b. only when all operators implement them, but the benefit varies considerably among operators.

2a. for an individual operator even when applied only by the operator, and all operators can achieve similar benefits by applying it later.

2b. for an individual operator even when applied only by the operator, but the benefit varies considerably among operators.

3. for an individual operator when applied only by the operator, and are harmful for other operators, if they are not using the same method.

4. for an individual operator even when applied only by the operator, but harmful for other operators, even when they are using the same method.

Evolution type 1a

Phase / Operator	1	2	3	4
C	o	o	o	+
B	o	o	-	+
A	o	-	-	+

- Beneficial only for an individual operator even when applied only by the operator, and all operators can achieve similar benefits by applying it later.
- Very problematic, but common!
  - many QoS systems
  - possible with strong common regulatory body, like ITU (earlier)
- Examples?

Evolution type 1b

Phase / Operator	1	2	3	4
C	o	o	o	o
B	o	o	-	+
A	o	-	-	+++

- Beneficial only when all operators implement them, and the benefit varies among all operators.
- Even if phase 4 were somehow reached, operator C has an incentive to return to phase 3 (due to competition)
  - practically impossible to reach phase 4, even with great gains for some operators

Evolution type 2a

Phase / Operator	1	2	3	4
C	o	o	o	+
B	o	o	+	+
A	o	+	+	+

- Beneficial for an individual operator even when applied only by the operator, and all operators can achieve similar benefits by applying it later.
- Temporary benefits during middle phases
  - still there is a business risk for early adopters (because the real outcome is difficult to predict)
  - strong motivation for patenting!

Evolution type 2b

Phase Operator	1	2	3	4
C	o	o	o	o
B	o	o	+	+
A	o	+++	+++	+++

- Beneficial for an individual operator even when applied only by the operator, but the benefit varies considerably among operators.
- Due to large temporary benefits during middle phases, evolution will likely be rapid
  - but stops to some middle phase

Evolution type 3

Phase Operator	1	2	3	4
C	o	-	- -	+
B	o	-	+	+
A	o	+	+	+

- Beneficial for an individual operator when applied only by the operator, and are harmful for other operators, if they are not using the same method.
- Due to large temporary benefits during middle phases, evolution will likely be very rapid
  - even a small gain is sufficient
  - patenting very beneficial

Evolution type 4

Phase Operator	1	2	3	4
C	o	-	- -	-
B	o	-	o	-
A	o	+	o	-

- Beneficial for an individual operator even when applied only by the operator, but harmful for other operators, even when they are using the same method.
- Extremely problematic: evolution tend to lead to harmful result for everyone!
  - Note: every separate move of each operator is reasonable!
  - Need for common regulator!

ATM - game

- Which type?
  - For operator: 1a/b
  - Similar for customers (need to invest to access device)
- Access vs. end-to-end connection
  - Internet:

Other points?