



Aalto University
School of Electrical
Engineering

Value Network Design for Internet

Case: Scenarios in Wireless Local Area
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Course S-38.3046
Aalto University

Issue of interest:

Indoor wireless access

- Currently, network connectivity to mobile devices is mainly provided by 2G and 3G – based wide area technologies, with outdoor macro and micro cells providing the required coverage and capacity to both indoor and outdoor located devices.
- Some WLAN-based indoor specific services exist, but at the moment in relatively small scale.
- There is considerable uncertainty about how network connectivity to indoor located devices will be provided in the future. In particular, the IMT-A systems can change the field in the indoor wireless access.

>> *How is network connectivity to indoor located devices provided in the future?*

- Role of operators, device vendors, end-users, site owners?
 - Network architecture / deployment strategy?
 - Radio technology / technologies?
- Time frame: ~10 years, until 2015-2020
 - Scope: Global, all indoor locations (homes, offices, public places), all wirelessly connected devices (not just mobile phones)

Workshop results

Prioritized list of key trends and uncertainties

Key trends

1. Number of access points increases
2. Devices are improved
3. Population is aging
4. Importance of indoor wireless access increases
5. Wireless traffic will increase
6. Role of developing countries increasing
7. Maintenance costs will dominate over hardware costs
8. Wireless emissions scare people

Key uncertainties

1. *Industry structure: horizontal vs. vertical*
2. *Number of technology substitutes: remain low or increase strongly*
3. *Spectrum policy and regulation: harmonized vs. liberalized (geographically and technology-wise)*
4. *Role of unlicensed spectrum: limited vs. significant*
5. Number of connected devices: Explode vs. grow modestly
6. Role of emerging markets in affecting technology choices

Correlations between uncertainties

	Horizontal industry structure	High n. of tech. substitutes	Liberalized spectrum policy	Significant role of unlicensed spectrum	Explosion in n. of devices	Powerful emerging markets
Horizontal industry structure	1	+	+	+	0	0
High n. of tech. substitutes	+	1	++	+	0	+
Liberalized spectrum policy	+	++	1	+	0	0
Significant role of unlicensed spectrum	+	+	+	1	++	0
Explosion in n. of devices	0	0	0	++	1	0
Powerful emerging markets	0	+	0	0	0	1

>> Two key criteria for scenario construction:

1. Industry structure: Horizontal or vertical
2. Access provisioning: Are WAN and LAN married or not

Criterion 1: Industry structure

Horizontal or vertical

- Vertical industry structure:
 - Access and services are bundled and sold as packages to end customers
 - Service portfolio contains everything that customer needs: voice, messaging, internet (music, social, etc.)
 - >> Lower level of competition between services
- Horizontal industry structure:
 - Services are offered individually from access, without bundling
 - Different service components are provided by different players (service, device, access, billing, etc.)
 - >> Higher level of competition between services

Criterion 2: Access provisioning

Marriage vs. divorce between WA and LA access

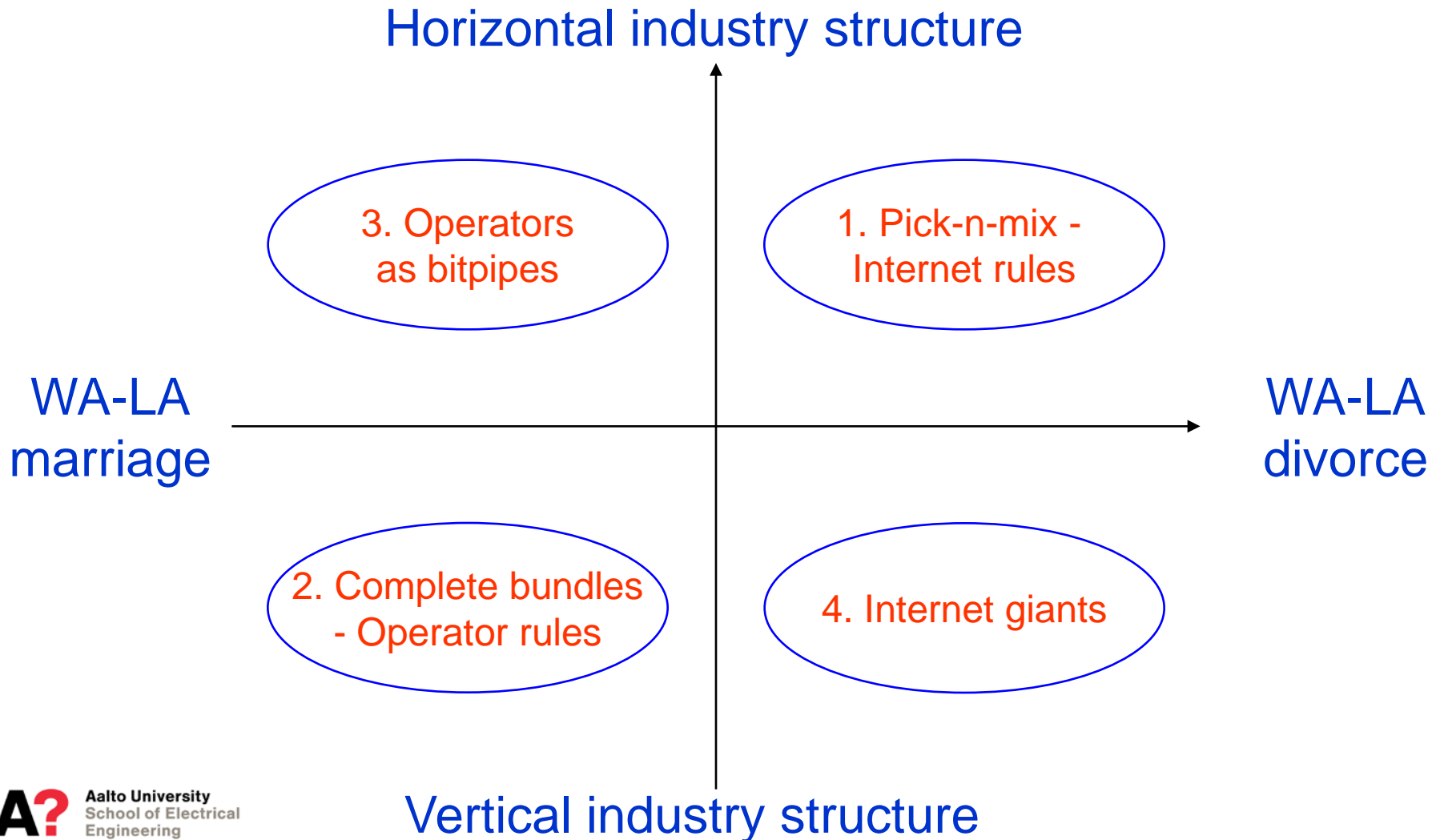
- WA-LA marriage:
 - Established mobile (WA) operators extend their control to local area networks
 - Utilizing either licensed or unlicensed technologies
 - Wide area and local area access provided as bundles
 - Few operators (~3-5) hold the essential spectrum licenses for providing public services, long license periods
 - Licenses granted for "technology families", e.g. IMT-A

>> Lower level of competition between access technologies and networks
- WA-LA divorce:
 - Local area access is separated from wide area access provisioning
 - Local access controlled by other players than established mobile operators
 - Local access provided both with licensed and unlicensed technologies
 - Spectrum policy favors competition in local access
 - Licensed spectrum becomes more flexible: technology neutrality, local licenses, spectrum trading, dynamic use
 - Unlicensed spectrum used as means to induce competition: regulator opens up new unlicensed spectrum
 - Number of local access operators and technologies is high

>> Higher level of competition between access technologies and networks

Scenarios

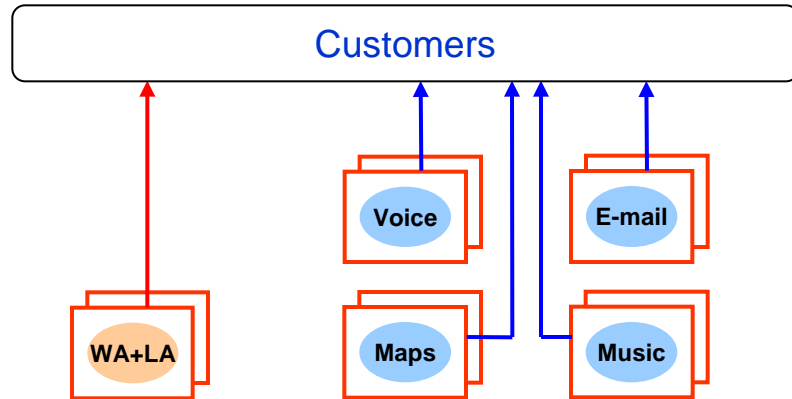
Four (not all) possible scenarios placed in a matrix



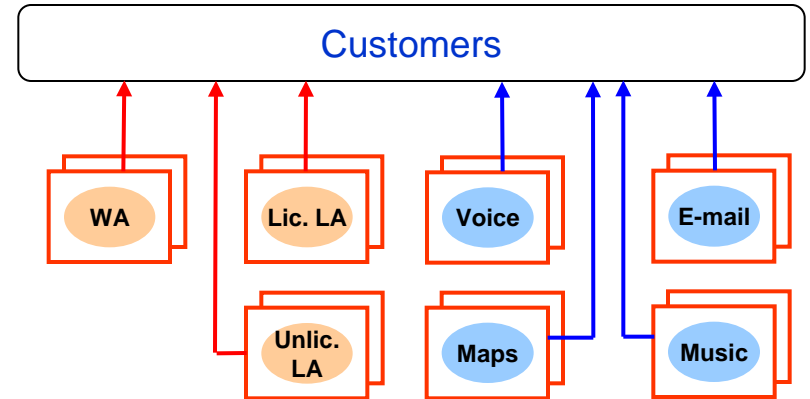
Scenario descriptions

Horizontal industry structure

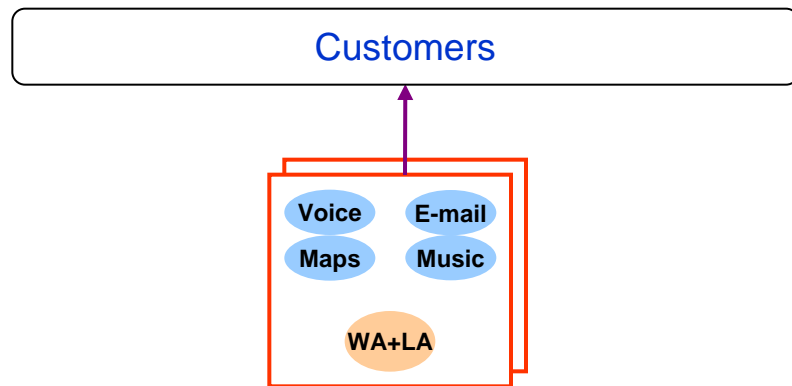
Scenario 3: Operators as bitpipes



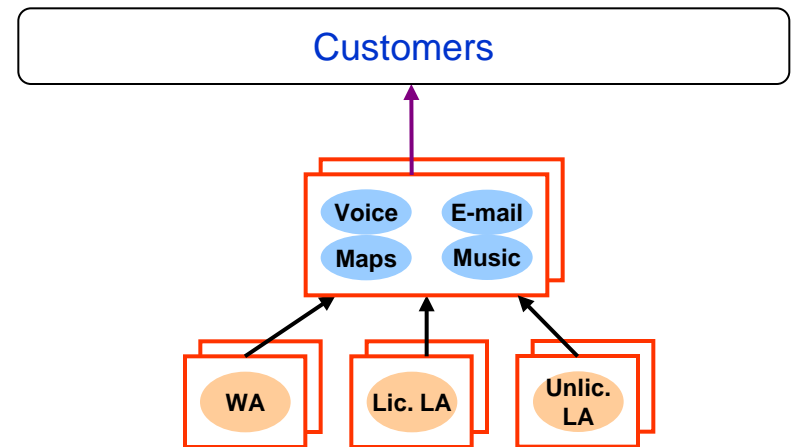
Scenario 1: Pick-n-mix



Scenario 2: Complete bundles



Scenario 4: Internet giants

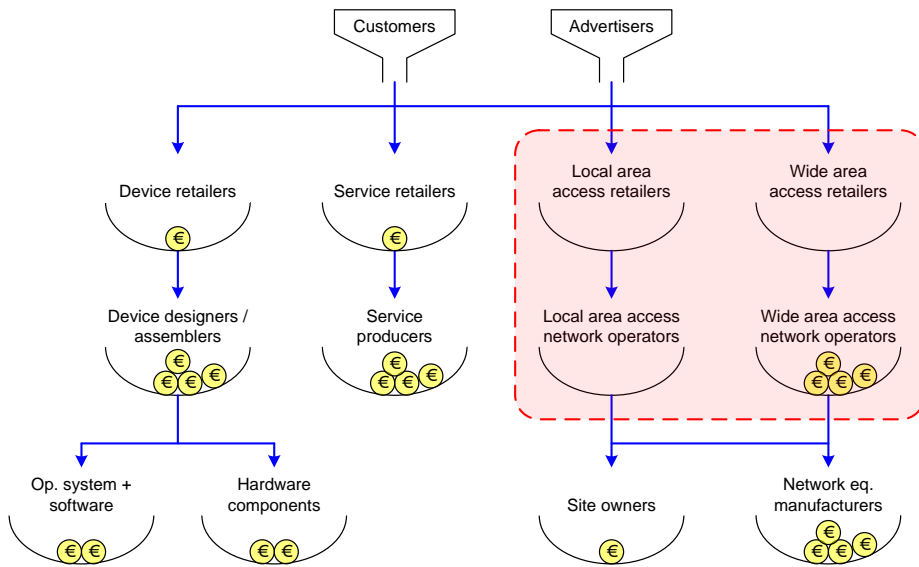


WA-LA marriage

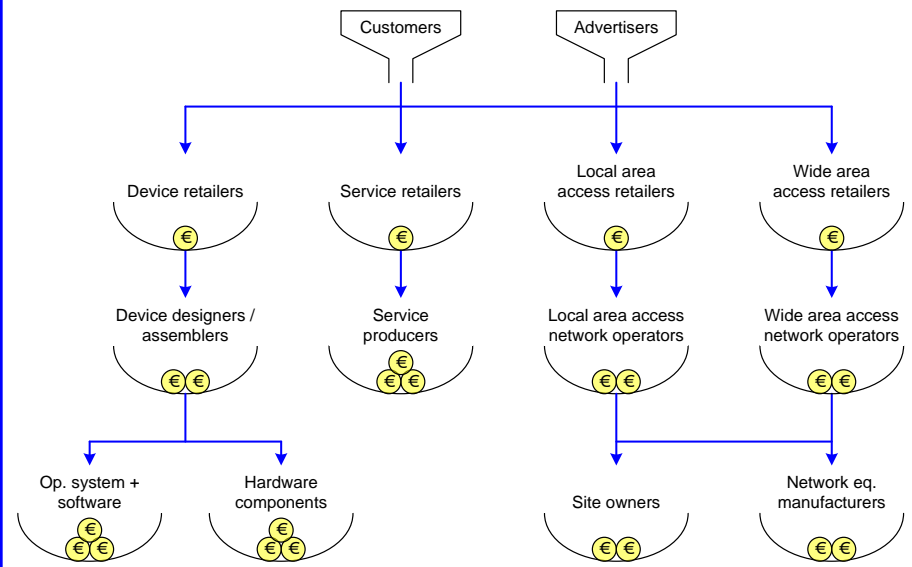
WA-LA divorce

Vertical industry structure

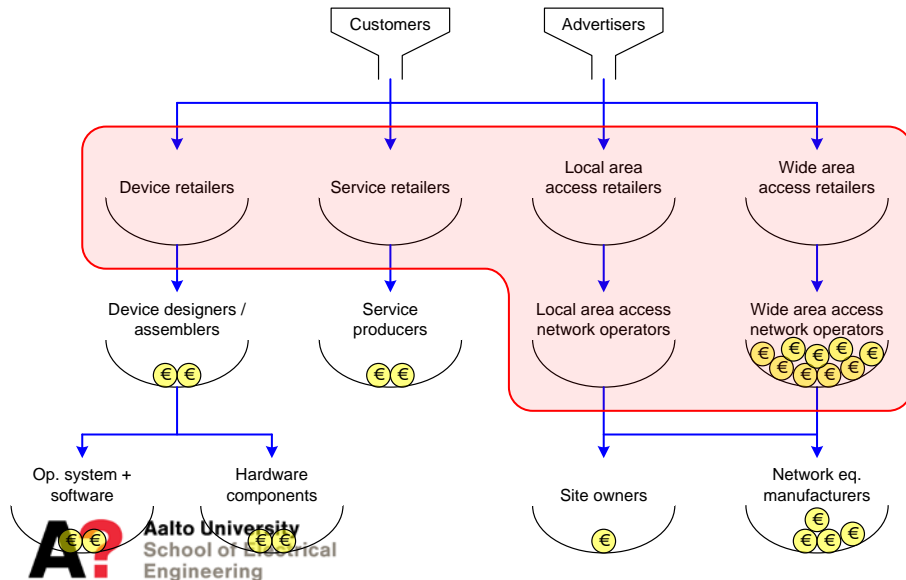
Scenario 3: Operators as bitpipes



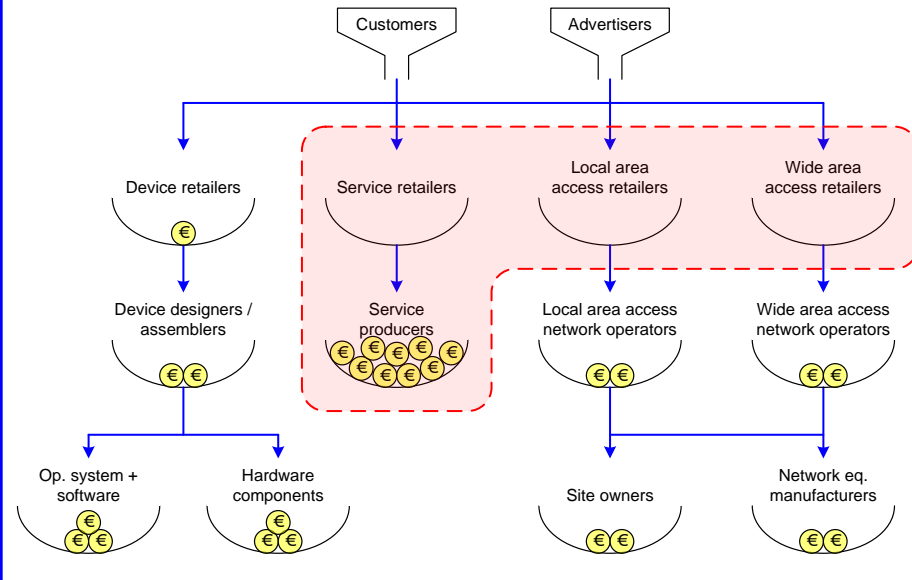
Scenario 1: Pick-n-mix



Scenario 2: Complete bundles



Scenario 4: Internet giants



Local access ecosystem

Roles, technologies, end-user viewpoint

Scenario 3: Operators as bitpipes

- Incumbents (established mobile WAN providers) control the local access, too
- Spectrum licensing favors a limited number of access operators, that compete with each other with similar offerings based on the same technologies (LTE-A)
- End-users buy bundles of accesses (separately from services) from established players
 - Flat rate access prices covering both WAN and local access
 - QoS critical services may provide additional revenue for access operators

Scenario 1: Pick-n-mix – Internet rules

- Many local access operators: Established mobile operators, site owners, specialized local access operators, broadband operators, communities, ...
- Technological fragmentation, many technologies
 - Both licensed (LTE-A LA, WiMAX LA) and unlicensed (WLAN+, others)
 - Abundant availability of unlicensed spectrum
- Access selection must be made convenient for the user
 - Roaming contracts between operators, roaming brokers
 - Intelligent agents that select the "optimal" access on behalf of the user
 - Complexity of pricing and payments has to be hidden, too

Scenario 2: Complete bundles – Operator rules

- Incumbent operators control local access
 - Local access provided as part of bundles, together with WAN access and services
 - Multiple local area deployments in hotspot locations (possibly spectrum sharing, FSU), or "advanced roaming"/hardware sharing between few operators
- Limited business opportunities for unlicensed spectrum
 - Utilized mostly in private networks
- End-users rely on operator for selecting the access
 - Bundled handsets configured and managed by the operator
 - Use of private local access (to offload WAN) can be encouraged
 - "home zone" pricing

Scenario 4: Internet giants

- Service bundles of Internet giants include access and roaming
- Open competition in local access provisioning
 - Traditional operators, specified local access operators, site owners / private persons
 - Provide access by wholesale / roaming arrangements
- Competition between local access technologies
 - Unlicensed vs. licensed, regardless of provider (incumbent vs. others)
- Network / technology competition not very visible to end-users, that subscribe to service bundles

Summary of effects on stakeholders

3) Operators as bitpipes		1) Pick n' Mix – Internet rules	
Incumbent MNOs	-	Incumbent MNOs	--
Challenger ANOs	-	Challenger ANOs	++
Virtual operators	+	Virtual operators	++
Service and content providers	+	Service and content providers	+
Site owners	0	Site owners	+
Device vendors	++	Device vendors	+
Network vendors	++	Network vendors	-
Regulators	+	Regulators	?
End customers	+	End customers	+
2) Complete bundles – Operator rules		4) Internet Giants	
Incumbent MNOs	++	Incumbent MNOs	--
Challenger ANOs	--	Challenger ANOs	+
Virtual operators	--	Virtual operators	0
Service and content providers	--	Service and content providers	++
Site owners	0	Site owners	+
Device vendors	-	Device vendors	-
Network vendors	++	Network vendors	-
Regulators	0	Regulators	0
End customers	-	End customers	+