



Network investments

S-38.041 Networking Business



Investment theory

Basic concepts

- Current (economic) cost vs. future (economic) benefit
 - High cost \Rightarrow big loan \Rightarrow long-term financial analysis
 - Value as function of time
 - *interest rate* of current loans (per market)
 - *discount rate* of future benefits (per actor)
 - *Cash flow* analysis (all costs and revenues over time)
- Investment portfolio
 - Comparison with best alternative (*opportunity cost*)
 - Freedom of *arbitrage* (no free lunches)
 - Continuous market dynamics \Rightarrow portfolio recalculation
- Consideration of material vs. immaterial assets



Investment theory

Tools – Without uncertainty

- Net Present Value (NPV)
 - $NPV = \sum_n x_n / (1+r)^n$, r = annual interest rate, n = years
 - Present value of asset's future cash flows (= inflow-outflow)
 - Tells the absolute profit (e.g. EUR), but not profitability (%)
- Internal Rate of Return (IRR)
 - IRR is the discount rate r that yields zero NPV
 - Tells the profitability, but not speed of cost recovery
- Payback Time (PBT)
 - $PBT = \text{Cost of project} / \text{Annual cash flows}$
 - Tells the speed of cost recovery in years



Investment theory

Tools – Under uncertainty

- Uncertainty comes from many sources
 - General market conditions (e.g. stock market bubbles)
 - Technology (e.g. transition to Internet technology)
 - Customer behavior (e.g. changing fashions)
 - Government (e.g. tax laws, competition policy)
 - Competitors (e.g. change of pricing to flat-rate)
- Coping with uncertainty
 - Choice of risk level (risk-averse, risk-seeking, risk-neutral)
 - Risk sharing (e.g. sharing of radio network capacity)
 - Low cross-correlation between *expected values* of investments \Rightarrow *diversification* reduces risk (e.g. Markowitz)
 - Parallel experimentation (ref. *real options* theory)



Operator investments

Big picture

- Types of large investments
 - Material (e.g. network capacity, distribution channel)
 - Immaterial (e.g. brand marketing, cellular licences)
- Types of funding
 - Risk-averse \Rightarrow *financial loans* (e.g. banks, equipment suppliers)
 - Risk-seeking \Rightarrow *equity investments* (e.g. governments, utility firms)
- Analysis methods
 - Calculation of incremental business case for service
 - Revenue modeling: accessible market \Rightarrow market share \Rightarrow ARPU
 - Cost modeling: network dimensioning \Rightarrow capacity \Rightarrow costs
 - Simulation with multiple scenarios (*what-if*)



Operator investments

Relative characteristics of selected cellular decision examples

	Cellular licence	Cellular coverage	Cellular capacity	New service
Decision mode	One-step	One-step	Incremental	Optional
Investment size	High or low	High	Medium	Low
CAPEX (%)	High (&low)	High	Medium	Low
OPEX (%)	Low	High	Low	Medium
Payback time	Long	Long	Short	Short

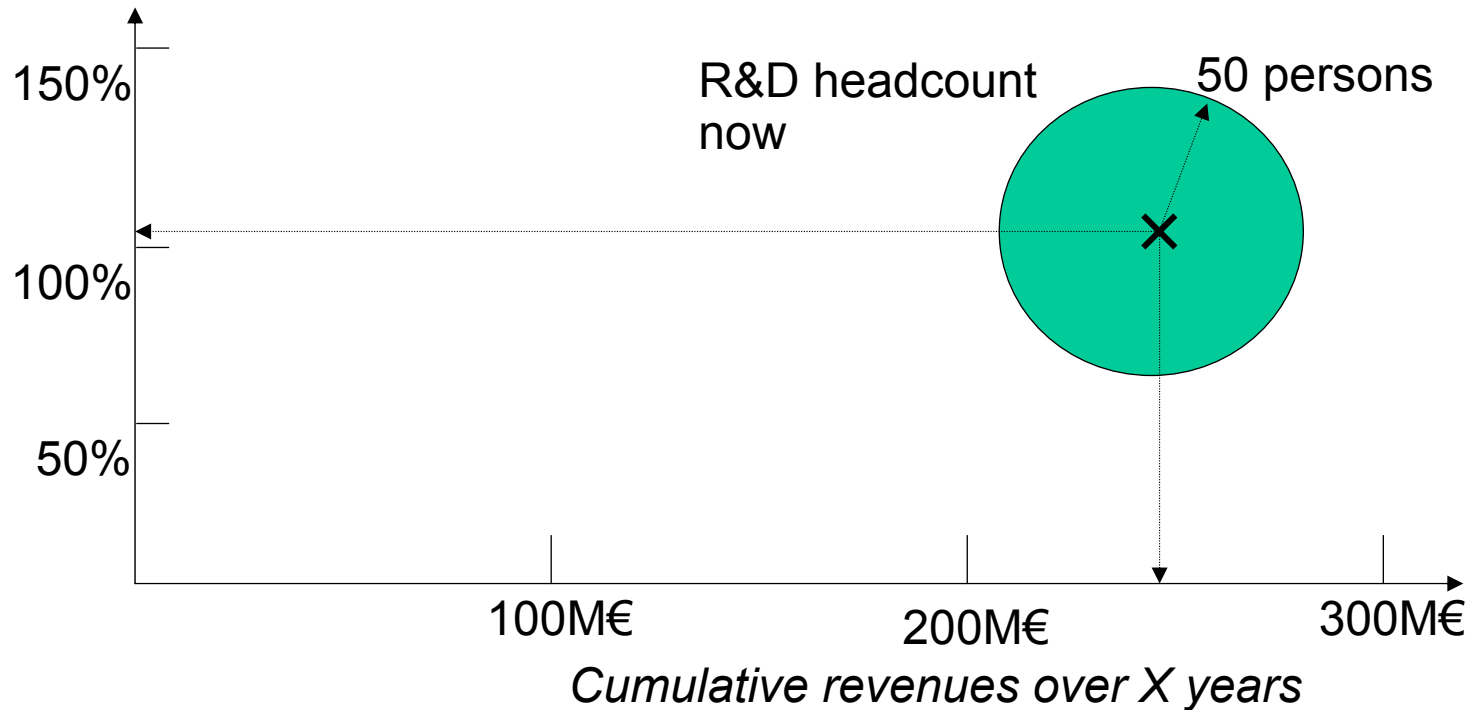
- Services are based on other services (e.g. MMS over GPRS)
- Cross-elasticity of services \Rightarrow high common cost \Rightarrow calculation problems



Portfolio analysis

Example (1/2)

Compound Annual Growth Rate
(CAGR) over X years



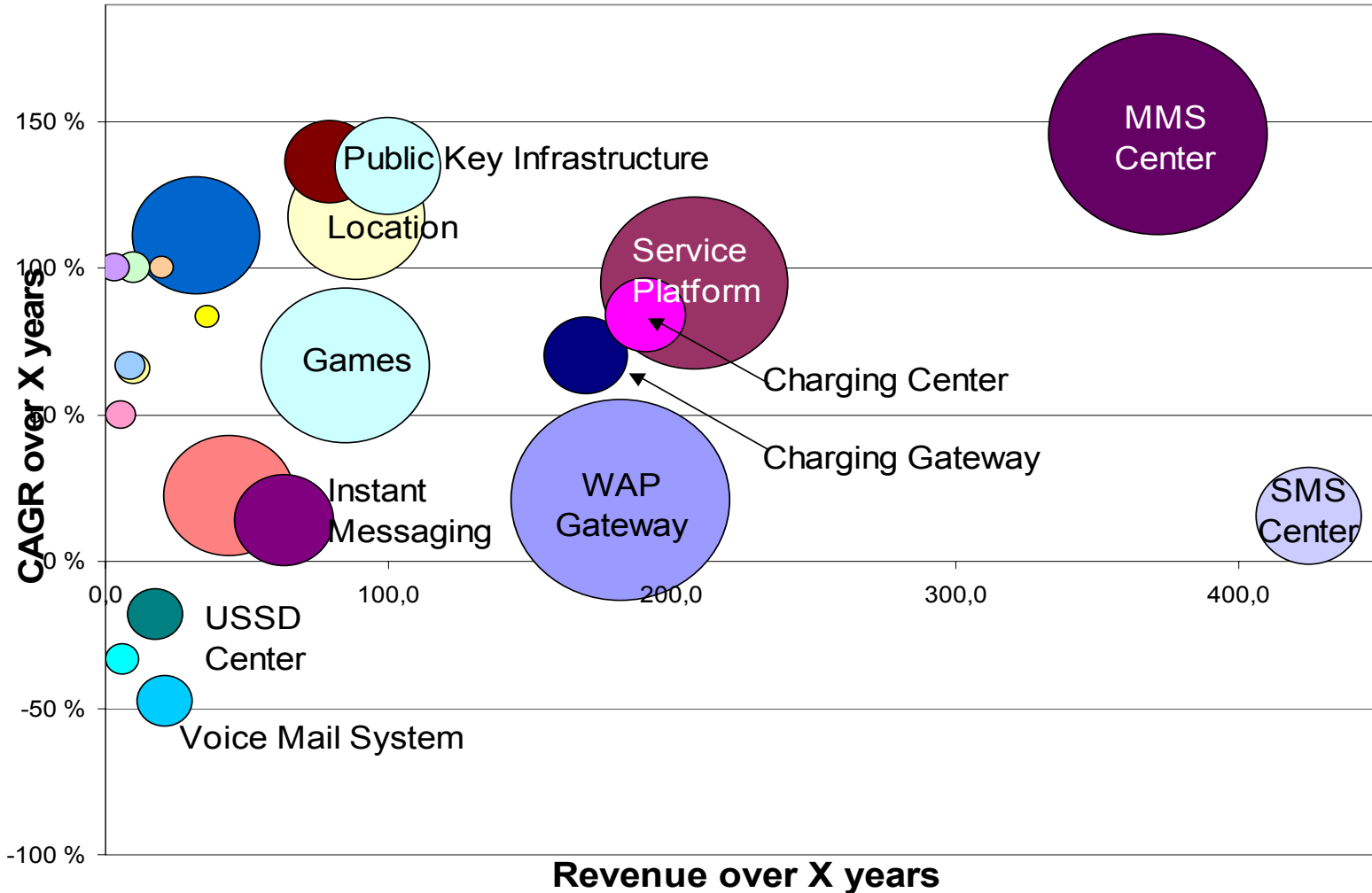
$$\text{CAGR} = \left(\frac{\text{Ending Value}}{\text{Beginning Value}} \right)^{\left(\frac{1}{\# \text{ of years}} \right)} - 1$$

- Focus on bottleneck resource (e.g. R&D experts)
- Decide the target period (e.g. 3 years)
- Get the latest estimate of sales, and probability



Portfolio analysis

Example (2/2)





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Rough Idea – Linear repeatable simulations

Inputs

Architecture:

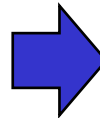
- Network elements and their prices

Services:

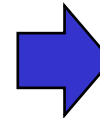
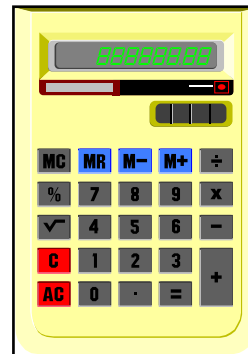
- penetration and tariffs

Business env:

- discount rate, tax rate etc.



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Outputs

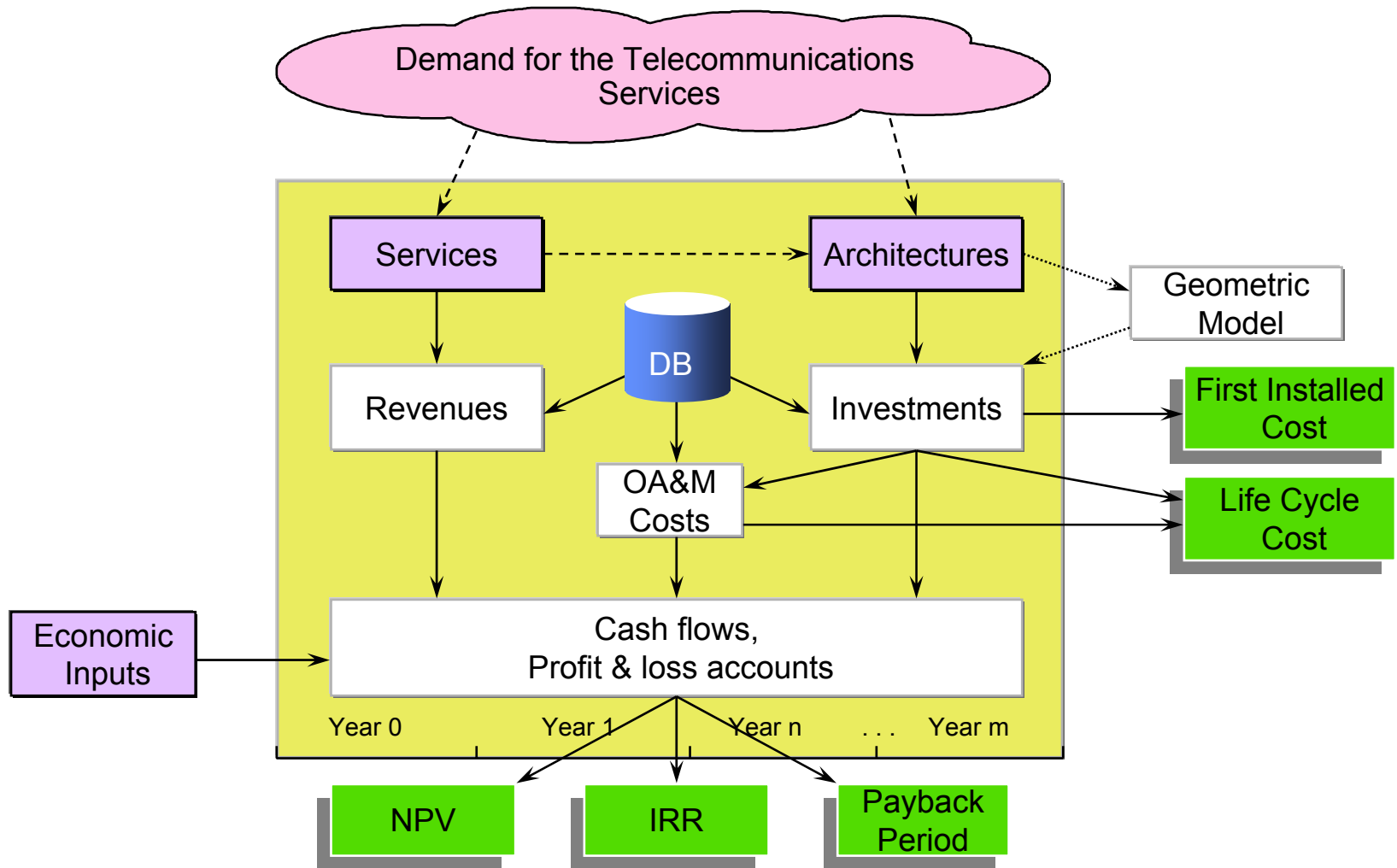
- Cash flows
- NPV
- IRR
- etc.

Source: EU TONIC project/Nokia Research center, 2002



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Information Flow





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The Shopping List (screen sample)

Microsoft Excel - DemoForICC.xls

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	A	D	E	F	G	H	I	J	K	L
1	Time Scale		-1	0	1	2	3	4	5	6
2	Year		1999	2000	2001	2002	2003	2004	2005	2006
3										
4										
5	Component	Level	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume
6	IP Router	FP2	0	1	1	1	1	1	2	2
7	ADSL_modem	FP1	0	200	365	648	1110	1790	2660	3592
8	DSLAM	FP1	0	1	1	2	3	4	6	8
9	ADSL_modem	FP0	0	200	365	648	1110	1790	2660	3592
10										
11										
12										
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15										
16										
17										
18										
19										

Architecture Parameters Time Series **Shopping List** OA Costs Component Data Service Penetrati

Data source: C:\tera16\TeraSample.tdb

NUM



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The Economics sheet (screen sample)

Microsoft Excel - DemoForICC.xls

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	A	B	F	G	H	I	J	K	L	M
2	NPV	661,259	2000	2001	2002	2003	2004	2005	2006	
3	IRR	56.3 %								
4										
5										
6	Investments		100,045	57,395	100,828	135,141	168,337	196,108	183,717	
7	Running Costs		24,519	40,901	64,729	104,028	162,582	239,132	323,691	
8	Revenues		69,200	117,257	193,968	308,744	462,729	639,346	805,531	
9	Cash Flows		-55,364	18,961	28,411	69,575	131,810	204,107	298,123	
10	Depreciations		10,005	15,744	25,827	39,341	56,175	75,785	94,157	
11	Profits		34,677	60,612	103,412	165,375	243,973	324,429	387,683	
12	Taxable Income		34,677	60,612	103,412	165,375	243,973	324,429	387,683	
13	Taxes		10,403	18,184	31,024	49,613	73,192	97,329	116,305	
14	Retained Cash Flows		-65,767	777	-2,613	19,963	58,619	106,778	181,818	
15	Cash Balance		-65,767	-64,990	-67,602	-47,640	10,979	117,757	299,575	
16										
17										
18										
19										
20										

GeneralGraph Economics User Outputs Log Revenues ServiceNumbers GlobalValues

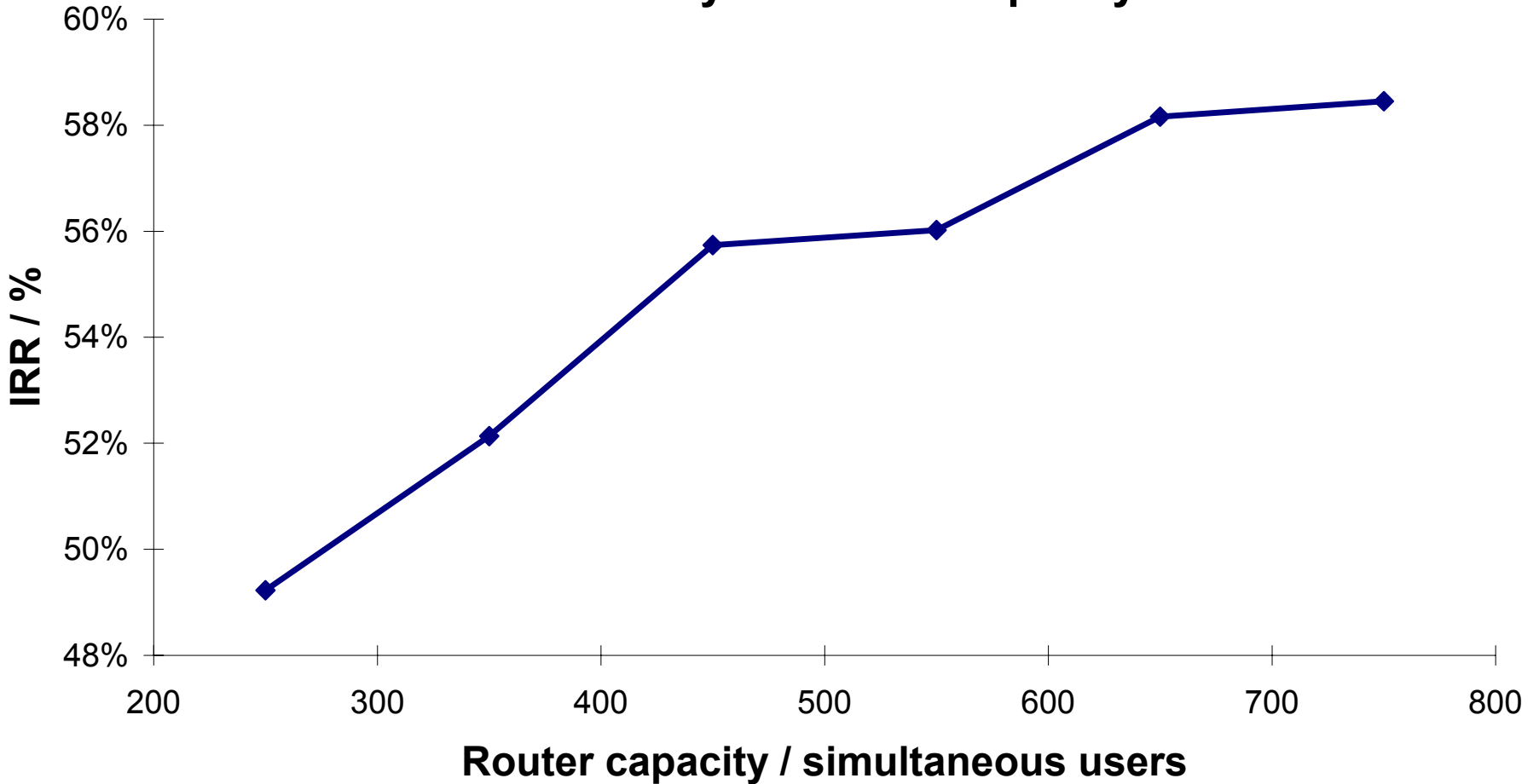
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Sensitivity analysis (example)

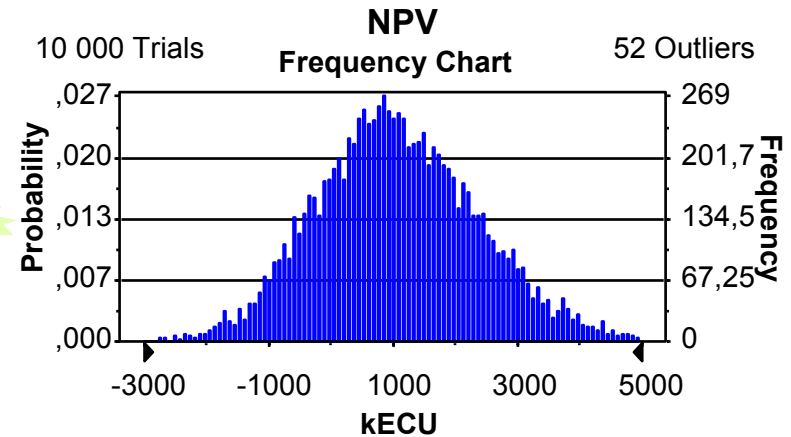
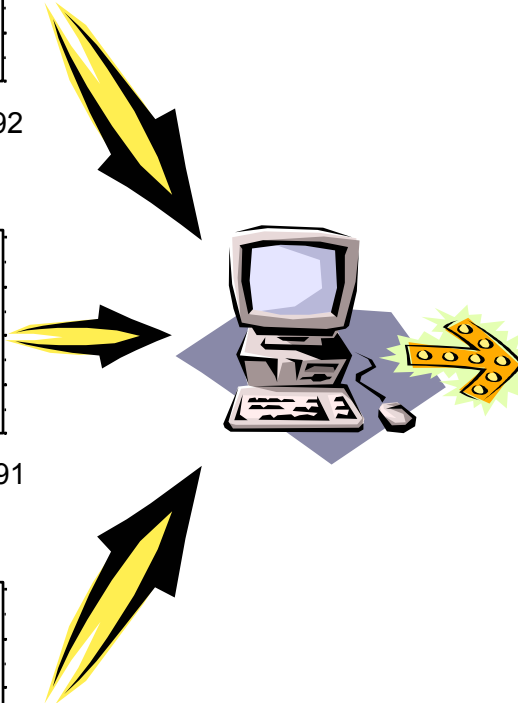
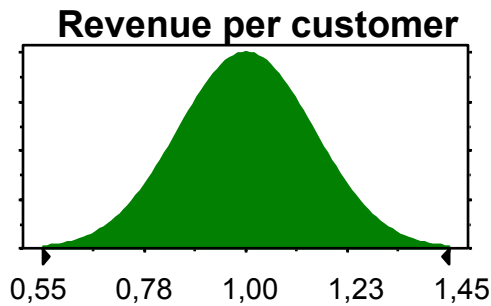
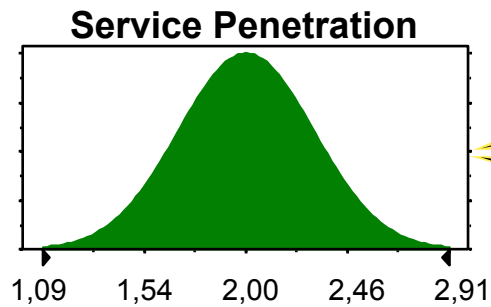
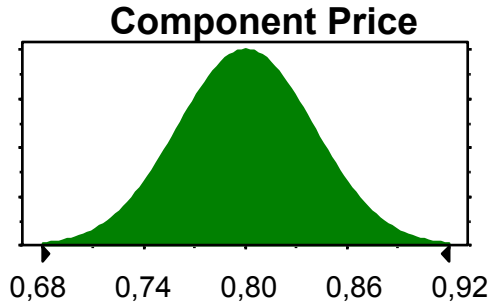
IRR sesitivity to Router Capacity





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Risk Analysis





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Case 3G & WLAN: Overview

- Comparison of 6 network scenarios (years 2002-2011)
 - Small country with slow roll-out, with/without WLAN services
 - Small country with fast roll-out (3 years, licence fee 2€/inhabitant)
 - Large country with high licence fee (90€/inhabitant), with/without WLAN
 - Large country with lower licence fee
- General assumptions
 - Incumbent operator: GSM \Rightarrow 3G \Rightarrow WLAN
 - WLAN for public indoor hotspots within 3G coverage area
 - Market forecasts based on non-linear S-shaped predictive procedure
 - Customers: 80% consumer, 20% business
 - Discount rate 10%
 - Handset subsidy 300€/new subscriber



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Case 3G & WLAN: Market forecasts

- Demand forecasts $Y_t = M/(1 + \exp(\alpha + \beta t))^\gamma$, where
 - Y_t : demand forecast at time t
 - M : saturation level (95% for small country, 90% for large)
 - α, β, γ : adjustable parameters for S-curve
- Subscribers used rather than subscriptions
- Pre-paid 65-80% and post-paid 20-35%
- Business/consumer usage ratio 2,5
- Total generated capacity demand estimate based on
 - Penetration percentage per service class, per market size
 - Average daily usage time per service class, per user
 - Average bit rate per service class, during usage time



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Case 3G & WLAN: Results

- 3G business case positive for all network scenarios with payback time of 7 years assuming long 20 year licence periods
- In small sparsely populated country, 3G network sharing facilitates 14% savings on investments
- Under nominal assumptions for 3G operators, public WLAN hotspots
 - Compliment, rather than compete, with 3G
 - Increase 3G usage by 8%
 - Generate 6% of combined WLAN/3G revenue (large countries)
 - Increase CAPEX by 1-2% and OPEX by 4-5%
 - Increase NPV of 3G operators by 9-18%



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Case 3G & WLAN: Sensitivity analysis

Delay of 3-4 years in 3G turns the business case negative

Sensitivity of 3G parameters ($\pm 50\%$) with regard to NPV

1. Tariff erosion
2. Megabyte tariff
3. Service usage
4. 3G cell radius
5. Operation, administration and maintenance
6. 3G service penetration
7. Investments

And sensitivity of WLAN wrt NPV (minor compared to 3G)

1. WLAN megabyte tariff
2. WLAN service penetration