Network investments
S-38.041 Networking Business

Investment theory
Basic concepts

- Current (economic) cost vs. future (economic) benefit
  - High cost ⇒ big loan ⇒ 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 the best alternative (opportunity cost)
  - Freedom of arbitrage (no free lunches)
  - Continuous market dynamics ⇒ 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 the speed of cost recovery

- **Payback Time (PBT)**
  - \( PBT = \frac{\text{Cost of project}}{\text{Annual cash flows}} \)
  - 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 ⇒ *financial loans* (e.g. banks, equipment suppliers)
  - Risk-seeking ⇒ *equity investments* (e.g. governments, utility firms)
- Analysis methods
  - Calculation of incremental business case for service
  - Revenue modeling: accessible market ⇒ market share ⇒ ARPU
  - Cost modeling: network dimensioning ⇒ capacity ⇒ costs
  - Simulation with multiple scenarios (*what-if*)

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Operator investments
Relative characteristics of selected cellular decision examples

<table>
<thead>
<tr>
<th>Decision mode</th>
<th>Cellular licence</th>
<th>Cellular coverage</th>
<th>Cellular capacity</th>
<th>New service</th>
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<tbody>
<tr>
<td>Investment size</td>
<td>High or low</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
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<tr>
<td>CAPEX (%)</td>
<td>High (&amp;low)</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
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<tr>
<td>OPEX (%)</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
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<td>Payback time</td>
<td>Long</td>
<td>Long</td>
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- Services are based on other services (e.g. MMS over GPRS)
- Cross-elasticity of services ⇒ high common cost ⇒ calculation problems
Portfolio analysis
Example (1/2)

- 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)
TONIC Tool
Rough Idea – Linear repeatable business case simulations

Inputs
- Architecture:
  - Network elements and their prices
- Services:
  - penetration and tariff
- Business env:
  - discount rate, tax rate etc.

Outputs
- • Cash flows
- • NPV
- • IRR
- • etc.

Architecture:
TONIC

Source: EU TONIC project/Nokia Research center, 2002

TONIC Tool
Information Flow

Demand for the Telecommunications Services

Services
Architectures

Revenues
Investments

OA&M Costs

Cash flows, Profit & loss accounts

Year 0
Year 1
Year n
... Year m

NPV
IRR
Payback Period

Geometric Model
First Installed Cost
Life Cycle Cost

Economic Inputs

Source: EU TONIC project/Nokia Research center, 2002
Tonic Tool
The Shopping List (screen sample)

<table>
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<tr>
<th>Year</th>
<th>Component</th>
<th>Level</th>
<th>Volume</th>
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Data source: C:\tera\tera\terasample.xls

Tonic Tool
The Economics sheet (screen sample)

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Data source: C:\tera\tera\terasample.xls
**TONIC Tool**

**Sensitivity analysis (example)**

**IRR sensitivity to Router Capacity**

- **Router capacity / simultaneous users**
  - 200
  - 300
  - 400
  - 500
  - 600
  - 700
  - 800

- **IRR / %**
  - 48%
  - 50%
  - 52%
  - 54%
  - 56%
  - 58%

**Tonic Tool**

**Risk Analysis**

- **Component Price**
  - 0.68
  - 0.74
  - 0.80
  - 0.86
  - 0.92

- **Service Penetration**
  - 1.09
  - 1.54
  - 2.00
  - 2.46
  - 2.91

- **Revenue per customer**
  - 0.55
  - 0.78
  - 1.00
  - 1.23
  - 1.45

- **NPV Frequency Chart**
  - 10,000 Trials
  - 269
  - 201
  - 134
  - 67
  - 25

- **Frequency**
  - -3000
  - -1000
  - 0
  - 1000
  - 3000
  - 5000

- **Probability**
  - 0.002
  - 0.004
  - 0.006
  - 0.008
  - 0.010
  - 0.012
  - 0.014

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Slide 13

Slide 14
TONIC Tool
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 ⇒ 3G ⇒ 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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TONIC Tool
Case 3G & WLAN: Market forecasts

• Demand forecasts $Y_t = M/(1+\exp(\alpha t+\beta t))^{\gamma}$, where
  – $Y_t$: demand forecast at time $t$
  – $M$: saturation level (95% for small country, 90% for large)
  – $\alpha$, $\beta$, $\gamma$: 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
TONIC Tool
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%

TONIC Tool
Case 3G & WLAN: Sensitivity analysis

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

Sensitivity of 3G parameters (±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