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Somebody Needs Your Algorithm

Part I: The Ekahau Story

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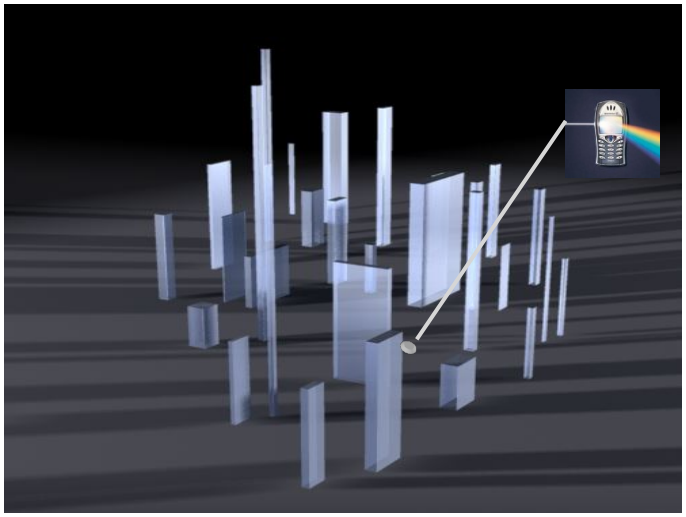
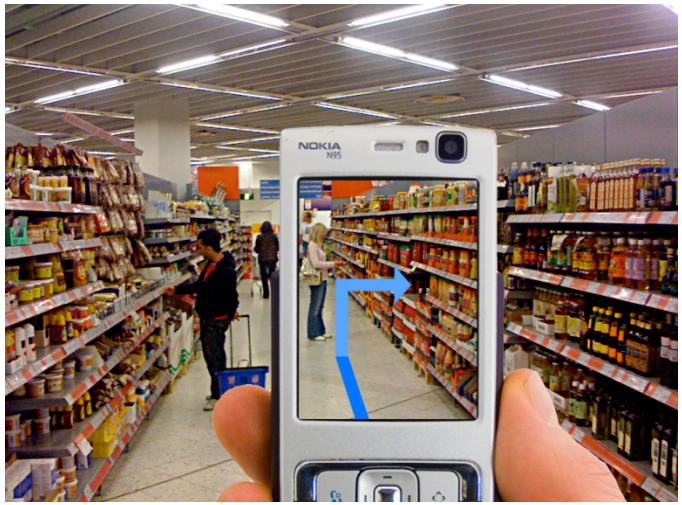
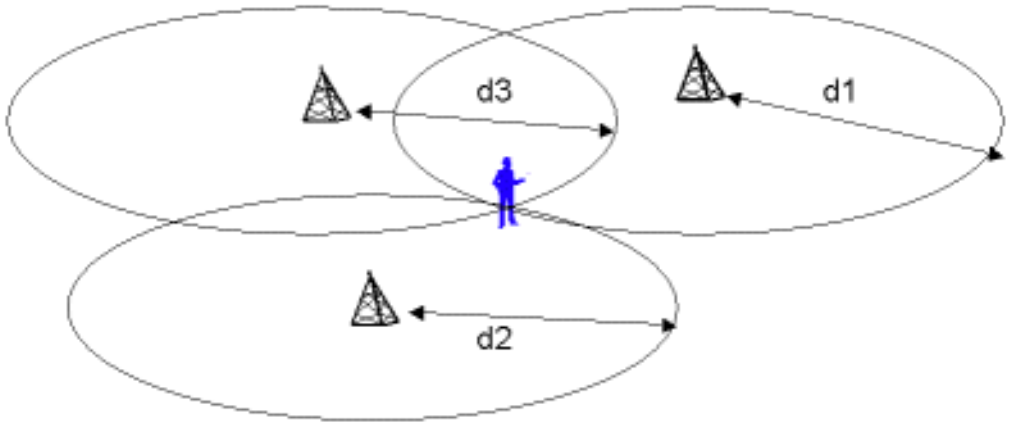
The Positioning Problem

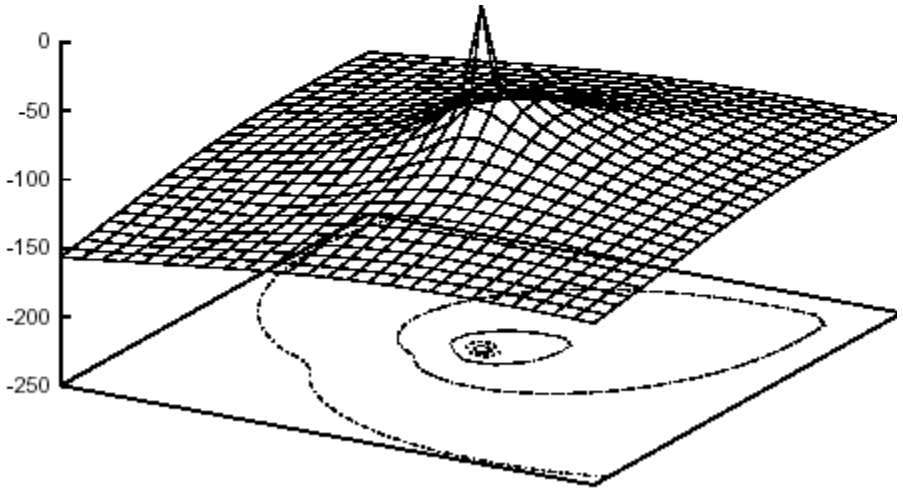


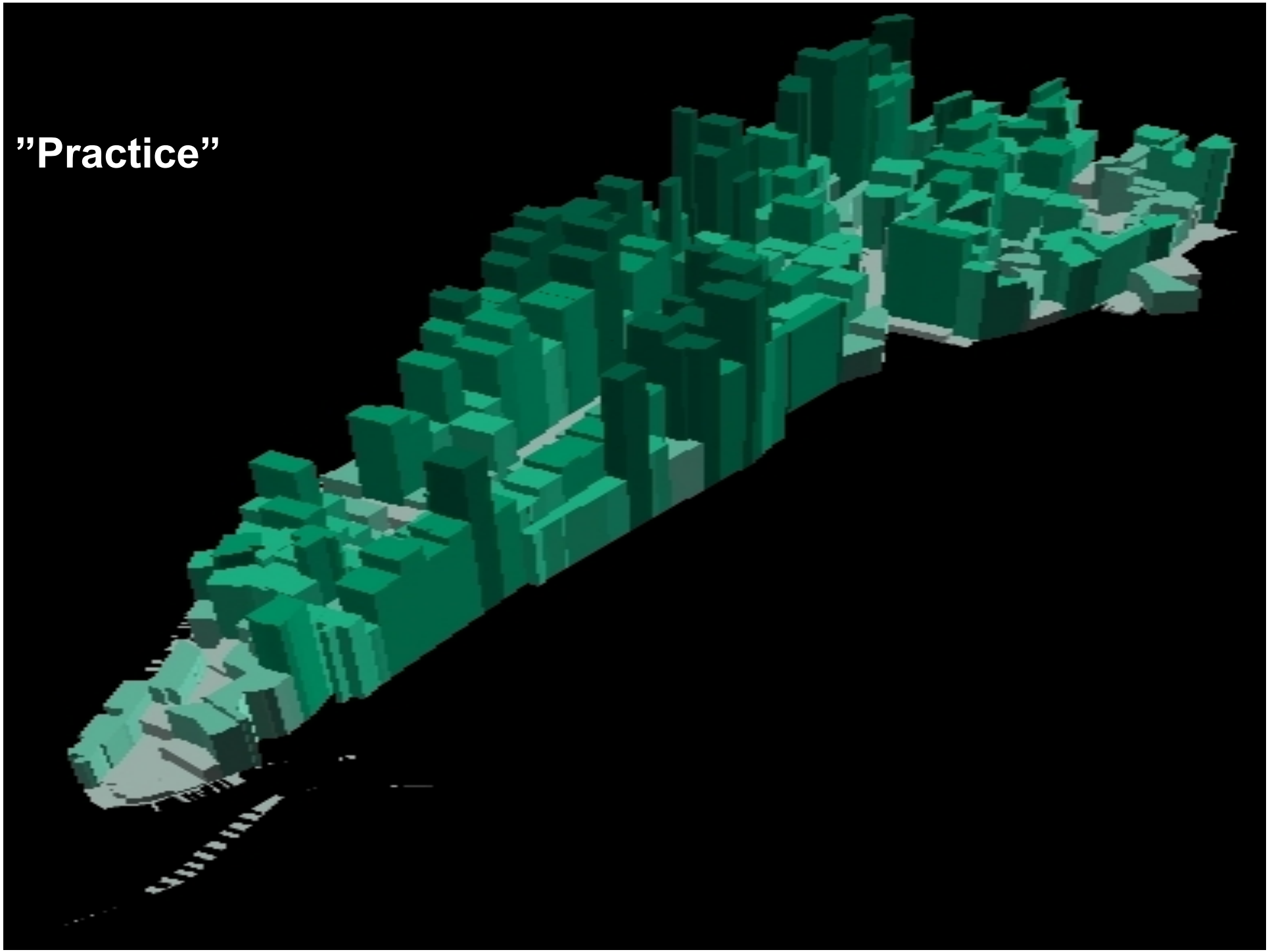
- Given some location-dependent observations *O,* measured by a mobile device, determine the location *L* of the device
- Why is this a good research problem?
  - The goodness of different solutions is extremely easy to validate (just go to a known location and test)
  - The results have immediate practical applications



”Theory”

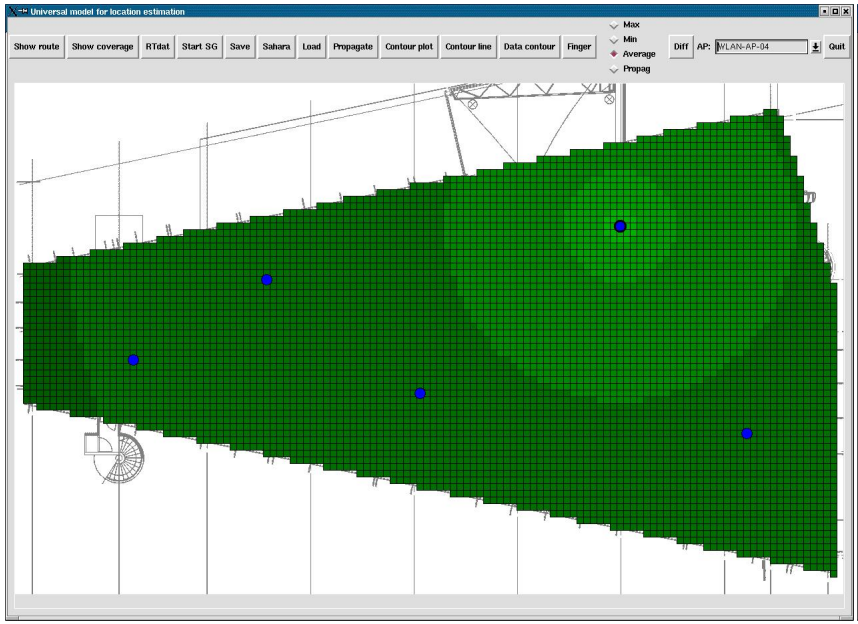




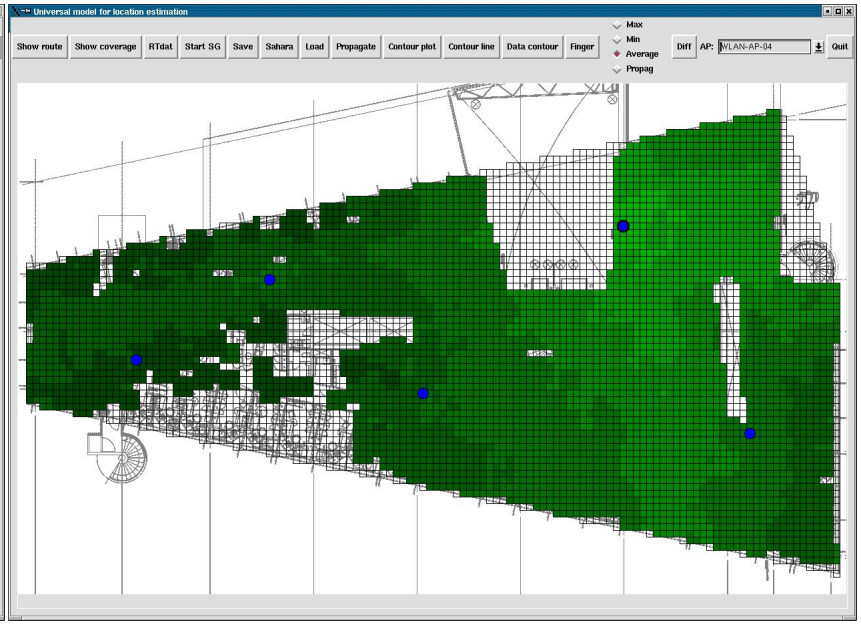

”Practice”

The Signal Propagation Approach

Theory



Reality



Problems with Traditional Approaches

- reflections, multi-paths
- no line of sight to BS
- extra hardware hard to utilize

A Probabilistic Approach to Positioning

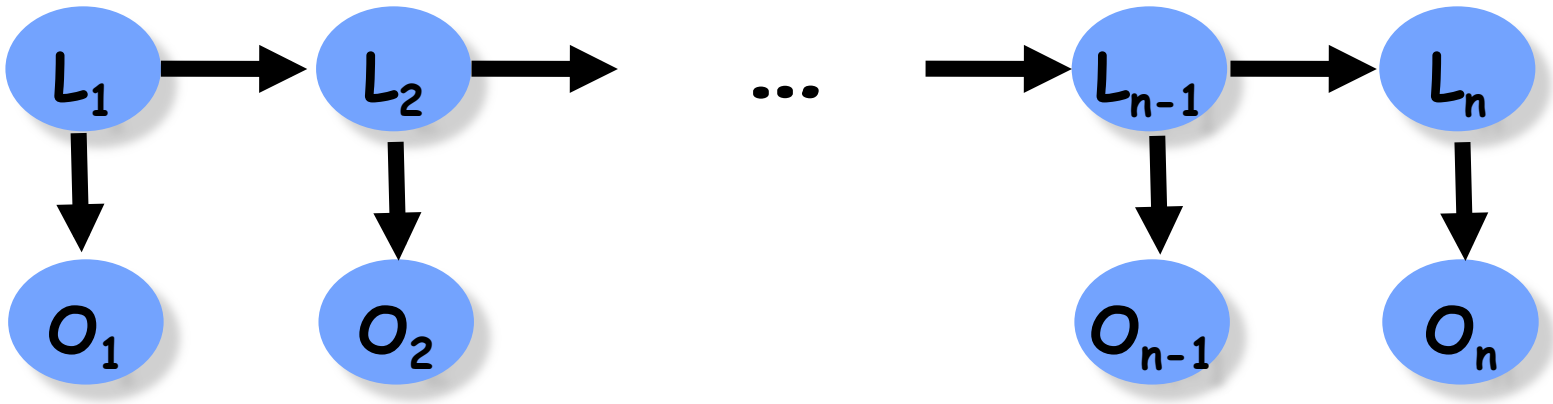
$$P(L \mid O) = \frac{P(O \mid L)\, P(L)}{P(O)}$$

- A probabilistic model assigns a probability for each possible location L given the observations O.
  - P(O | L) is the conditional probability of obtaining observations O at location L.
  - P(L) is the prior probability of location O. (Could be used to exploit user profiles, rails etc.)
  - P(O) is just a normalizing constant.
- How to obtain P(O | L)?

  ⇨ **Empirical observations + machine learning**

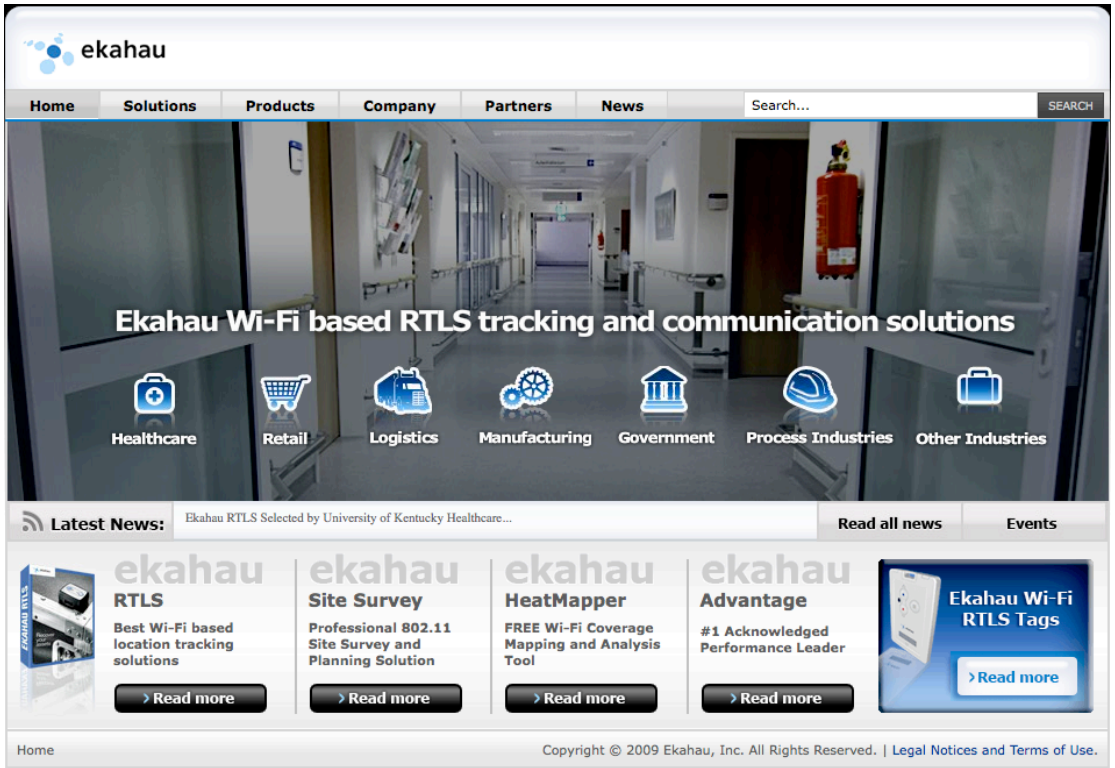
Tracking with Markov Models

- Typically we have a sequence (history) of observations $O_1, \ldots, O_n$, and wish to determine $P(L_n \mid O^n)$
- Assumption: $P(O_t \mid L_t)$ are known, and given location L_t, the observation O_t is independent of the rest of the history
- The model: a hidden Markov model (HMM) where the locations L_t are the hidden unobserved states
- The transition probabilities $P(L_t \mid L_{t-1})$ can be easily determined from the physical properties of the moving object



WiFi Positioning & Ekahau

- *P.Myllymäki, T. Roos, H.Tirri, P.Misikangas and J.Sievänen,. A Probabilistic Approach to WLAN User Location Estimation. International Journal of Wireless Information Networks, Vol. 9, No. 3, July 2002.*
- *T. Roos, P. Myllymäki, H. Tirri, A Statistical Modeling Approach to Location Estimation. IEEE Transactions on Mobile Computing, Vol. 1, No. 1, January-March 2002, 59-69.*
- *P. Kontkanen, P. Myllymäki, T. Roos, H. Tirri, K. Valtonen, H. Wettig, Topics in Probabilistic Location Estimation in Wireless Networks. Invited paper in Proceedings of the 15th IEEE Symposium on Personal, Indoor and Mobile Radio Communications, Barcelona, Spain. IEEE Press, 2004.*
- *P. Kontkanen, P. Myllymäki, T. Roos, H. Tirri, K. Valtonen, H. Wettig, Probabilistic Methods for Location Estimation in Wireless Networks. Chapter 11 in Emerging Location Aware Broadband Wireless Adhoc Networks, edited by R.Ganesh, S.Kota, K.Pahlavan and R.Agustí. Kluwer Academic Publishers, 2004.*



Success!

ekahau

- Founded in 2000, several funding rounds since then
- First stock holders Henry Tirri (currently CTO of Nokia), Petri Myllymäki + 7 other members of the university research group
- Several awards: The European Information Society Technology Prize 2002, Technology Marketing Corporation: Best product of the year 2002, Software Industry Summit: Best commercialized innovation in Finland in 2002, Frost & Sullivan: Technology Leadership Award 2005, Red Herring (2008): one of the top 100 tech start-ups in North America, …
- Offices in Americas, EMEA, and APAC
- Market leader in the chosen business sectors, over 100 resellers and over 10 000 users worldwide

…Success?

- Starting a spin-off is hard
- Running a company is even harder
- …and most importantly, most of stuff you will be facing are not very interesting, and above all, just **NOT FUN!**