

Taking into Account Multiple Use Environments by Mixed Distributions Concept

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September 26th 2008

Outline

- **Background and motivation**
- How to take into account different environments?
- Mixed distributions concept
- An example: component in 4 different environments
- Conclusions
- Q&A

Background

- Field environment is known to have a significant effect on reliability. The whole P-o-F approach is based on that.
- Due to advances in sensor technology, it is nowadays possible to collect significant amounts of climatic data, as well as data on the actual environment a certain device – or even an individual component - experiences.

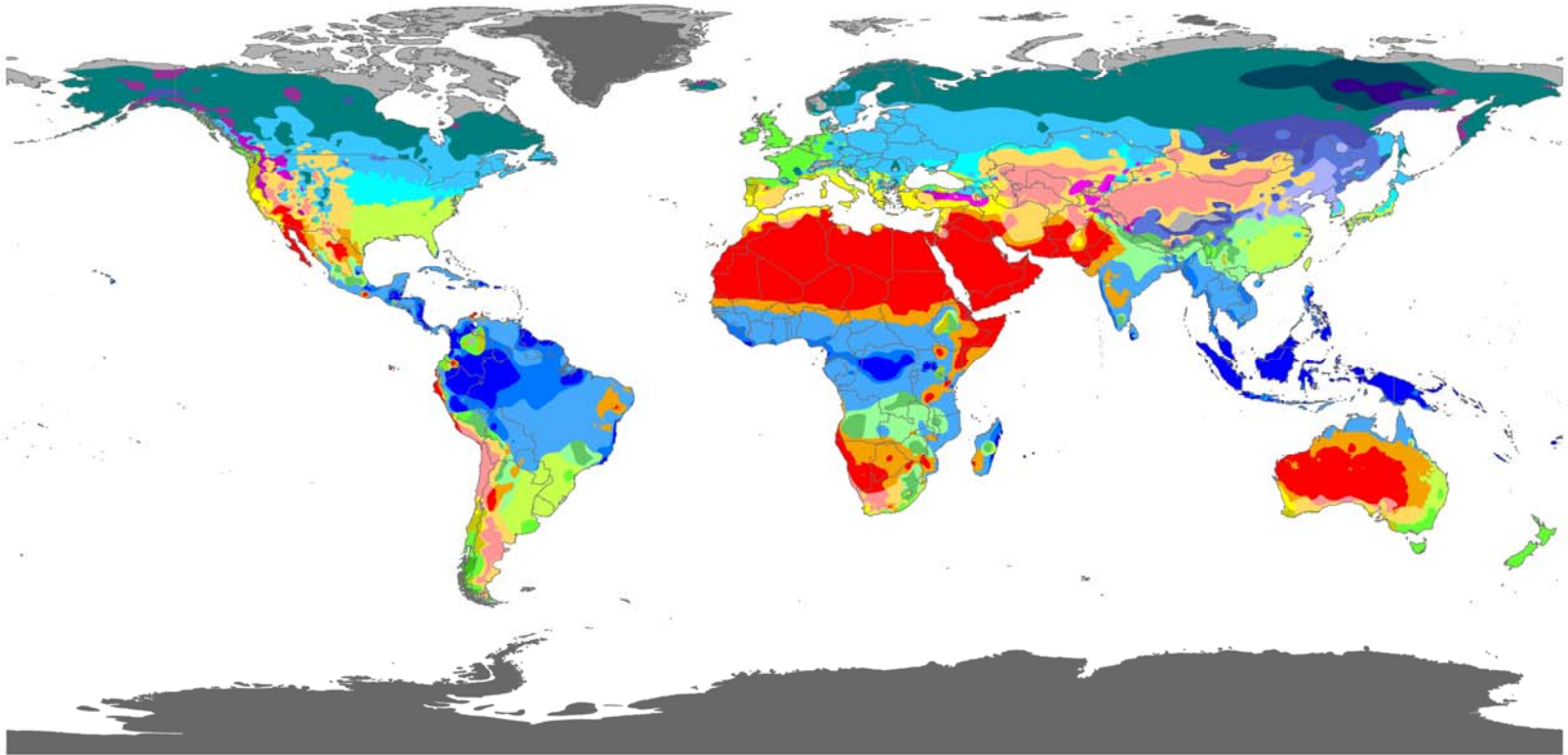
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How to take into account different environments?

- Evidently, some processing of raw data is always needed in order to filter out some noise etc.
- The decision on how to actually use this information is a more complex question. For that, there are several strategies:
 - find max and min values and use those (→ risk of over-design)
 - use average values (→ risk of over-averaging, loss of information)
 - **use categories**. Usually the best compromise. For example, Köppen climate classification.

World map of Köppen-Geiger climate classification



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Af	BWh	Csa	Cwa	Cfa	Dsa	Dwa	Dfa	ET
Am	BWk	Csb	Cwb	Cfb	Dsb	Dwb	Dfb	EF
Aw	BSh	Cwc	Cfc	Dsc	Dwc	Dfc		
	BSk	Dsd	Dwd	Dfd				

Contact : Murray C. Peel (mpeel@unimelb.edu.au) for further information

DATA SOURCE : GHCN v2.0 station data
Temperature (N = 4,844) and
Precipitation (N = 12,396)

PERIOD OF RECORD : All available

MIN LENGTH : ≥30 for each month.

RESOLUTION : 0.1 degree lat/long

Nokia Siemens
Networks



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Mixed distributions concept

- Known in the literature, e.g. Hansen and Thyregod use it for when handling good components and those with initial defects.
- First introduced in conjunction with different use environments:

Salmela O, Application of Mixed-Field-Environments Concept in Lifetime Prediction, Quality and Reliability Engineering International, vol. 23, pp. 961-971, 2007.

Mixed distributions concept, the basics

- Multiple, different field environments i , share of components placed in each field environment is p_i

$$f(t) = \sum_{i=1}^n p_i f_i(t)$$

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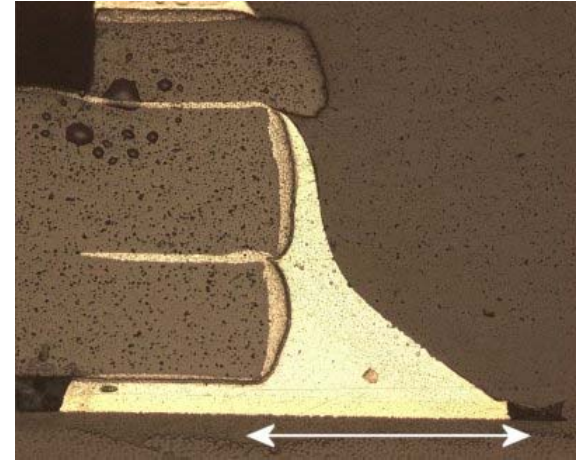
$$R(t) = \sum_{i=1}^n p_i R_i(t)$$

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Component under consideration

- SAW IF filter, packaged in ceramic → large CTE mismatch
- Solder castellations



→ increased interconnection-related reliability risk

- T/C results: $-40 \dots +125$ °C, 1-hour cycle → $\eta=609$, $\beta=7.8$

Field environments

	<i>Fast soft</i>	<i>Fast hard</i>	<i>Day soft</i>	<i>Day hard</i>
Start temp. [°C]	27.5	37.5	30	50
Max. temp. [°C]	37.5	75	40	80
Min. temp. [°C]	17.5	40	20	20
Time min->max [min]	8	5	360	360
Dwell time at max [min]	43	5	360	360
Time max->min [min]	10	34	360	360
Dwell time at min [min]	3	5	360	360

Field performance

- FEM, Acceleration Factors (A.F.)

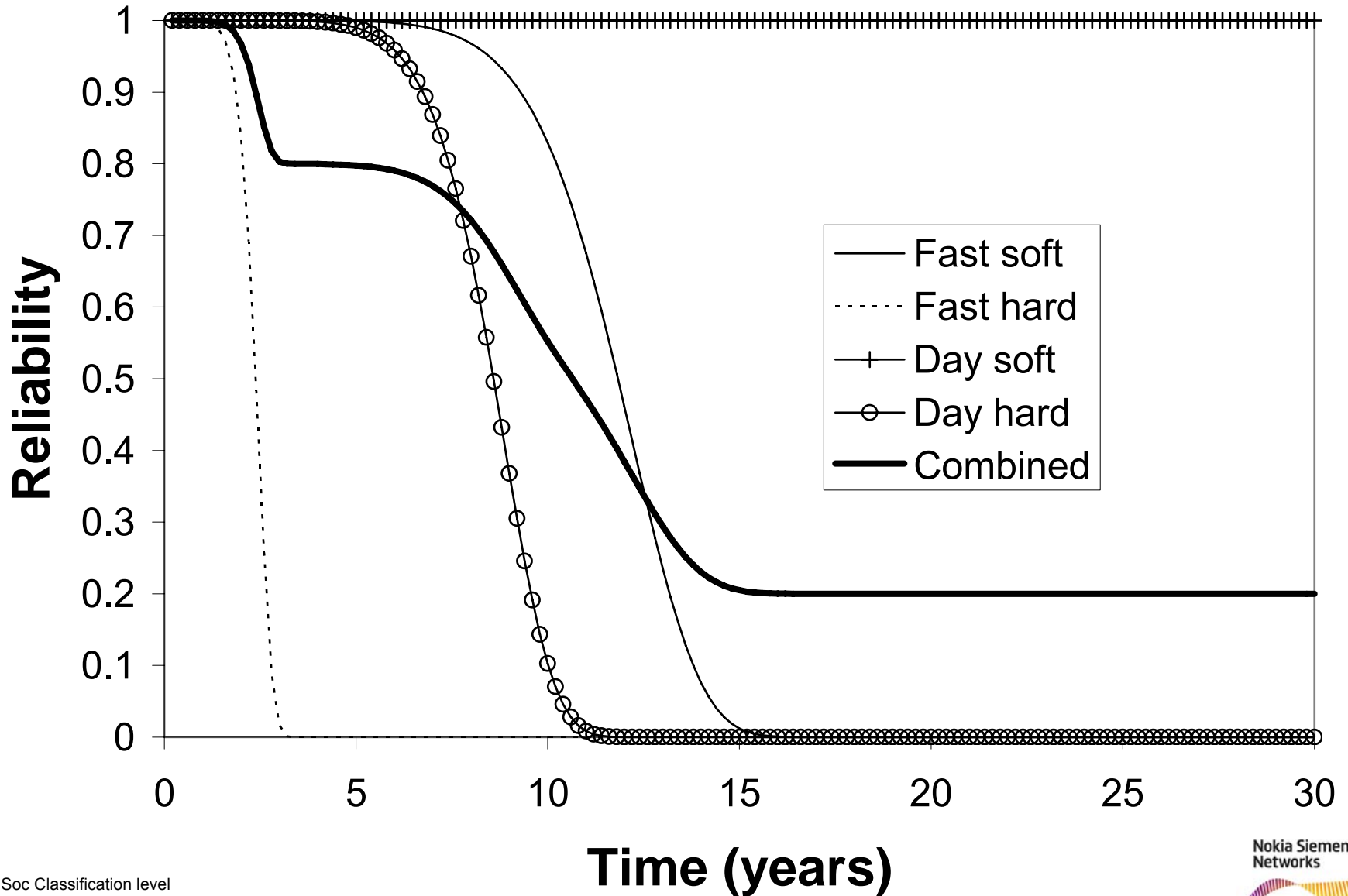
Fast soft	Fast hard	Day soft	Day hard
167.6	44.6	122.4	5.4

- 40% fast soft, 20% all other environ's
- Input to Eqs. on slide 9

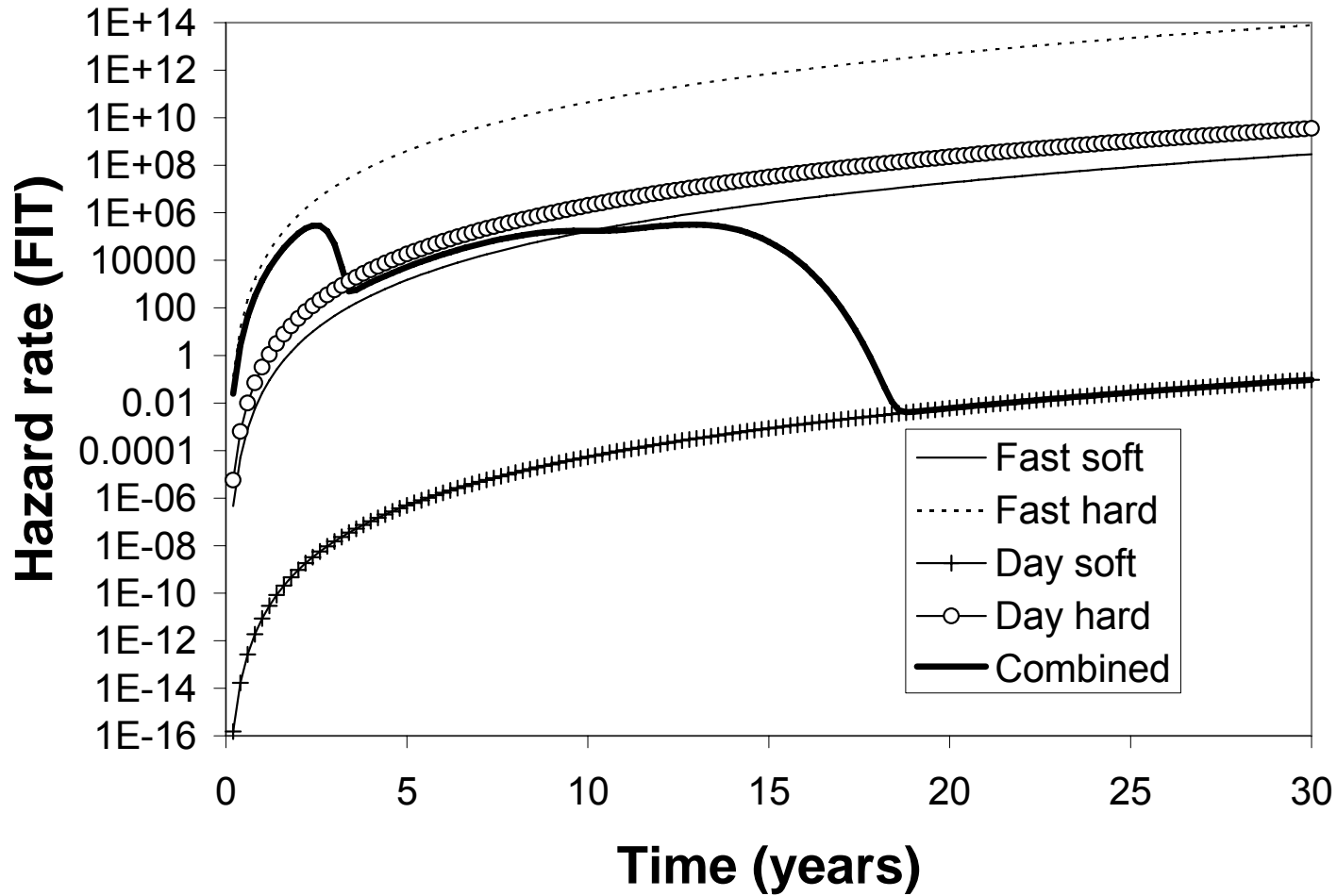
$$f_i = \frac{\beta}{(\eta \cdot A.F._i)^\beta} \cdot t^{\beta-1} \cdot e^{-\left(\frac{t}{\eta \cdot A.F._i}\right)^\beta}$$

$$R_i(t) = e^{-\left(\frac{t}{A.F._i \cdot \eta}\right)^\beta}$$

Reliability



Hazard rate



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Conclusions

- New method on how to take into account multiple field environments introduced.
- It is possible to study the effect of different environ's on the whole component population. Based on that one can decide:
 - use the same component globally, being prepared for preventive maintenance, calculate the need for spare parts
 - use different components for each field environment
 - switch the component to one that has a better reliability and use it globally
- Optimizing the lifetime cost is the ultimate goal.

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THANK YOU!

Questions & Comments?

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