Dependability in Latin America: A Brief History

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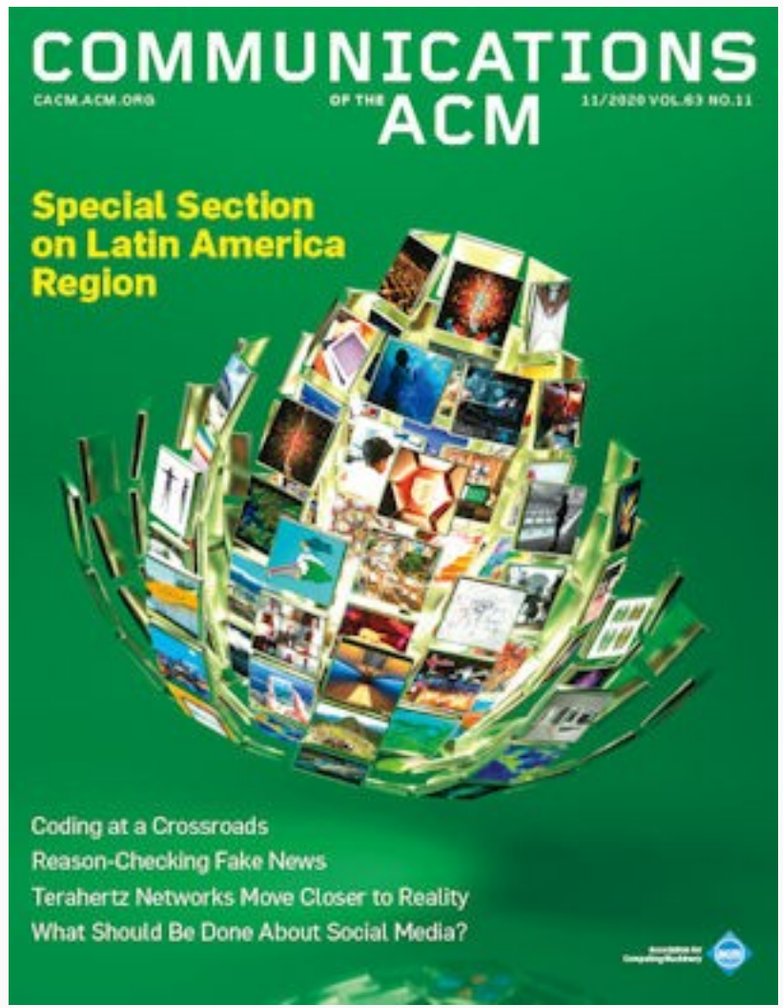
Agenda

- Early dependability efforts in Latin America
- What came next & a few research highlights: a historical perspective
- Challenges & Future Directions

A Source

- In 2020 the Communications of the ACM published a Special Issue on Computing in Latin America
- Elias P. Duarte Jr, Raimundo J. Macêdo, Eliane Martins, & Sergio Rajsbaum, “A Tour of Dependable Computing Research in Latin America,” *Communications of the ACM*, Vol. 63, No. 11, pp. 96-101, 2020.



Just to be sure…

- **Dependability** is the set of techniques to build, configure, operate, and manage computer systems to ensure that they are *reliable, available, safe, and secure*
  - Faults are inherent to computer systems…
  - … and organizations & individuals increasingly rely on systems working correctly

Early Dependability Efforts

- The first research efforts on dependable computing in Latin America were on aerospace systems

- INPE: Instituto Nacional de Pesquisas Espaciais

  Brazilian Aerospace Institute

- https://www.gov.br/inpe/pt-br
- Established in São Paulo, Brazil, in the early 1960s

One of the early INPE satellites

- Some of the early dependability projects developed at INPE included the robustness of satellites, including altitude and orbit control
- This is the SCD-1 satellite:

In 1985: The 1st SCTF

- Alderico Rodrigues de Paula Jr., one of the INPE researchers in charge of satellite projects...

- ... organized (at INPE) in 1985 the very
- 1st Brazilian Symposium on Fault-Tolerant Computing
  - 1º Simpósio Brasileiro de Computação Tolerante a Falhas (SCTF'1985)

There followed **18 years** of SCTF!

- Actually 1 edition every 2 years:
  - I 1985 São José dos Campos/SP
  - II 1987 Campinas/SP
  - III 1989 Rio de Janeiro/RJ
  - IV 1991 Gramado/RS
  - V 1993 São José dos Campos/SP
  - VI 1995 Canela/RS
  - VII 1997 Campina Grande/PB
  - VIII 1999 Campinas/SP
  - IX 2001 Florianópolis/SC → The 0th LADC

The Latin American Dependable and Secure Conference (LADC)

- In 2001, English was mandatory for all SCTF papers
  - there was a large international participation → *The 0th LADC*
- The Brazilian Dependability Computing community had been long consolidated into the CE-TF:
  - Comissão Especial de Computação Tolerante a Falhas da Sociedade Brasileira de Computação (SBC)
  - *Special Interest Group on Fault Tolerant Computing of the Brazilian Computer Society*

LADC: since 2003, 22 years

1) LADC’2003: São Paulo, Brazil
2) LADC’2005: Salvador, Brazil
3) LADC’2007: Morella, Mexico
4) LADC’2009: João Pessoa, Brazil
5) LADC’2011: São José dos Campos, Brazil
6) LADC’2013: Rio de Janeiro, Brazil
7) LADC’2016: Cali, Colombia
8) LADC’2018: Foz do Iguaçu, Brazil
9) LADC’2019: Natal, Brazil
10) LADC’2021: Florianópolis, Brazil
11) LADC’2022: Fortaleza, Brazil
12) LADC’2023: La Paz, Bolivia
13) LADC’2024: Recife, Brazil
14) LADC’2025: Valparaiso, Chile

Please submit to LADC'2025!

LADC'2025

- The deadline for research papers: May, 2025
- Chile & Valparaiso (very close to Santiago!)
- https://ladc.sbc.org.br/2025/

LADC'2025: Valparaiso

- That's the only city in the world with a real MOAI in a park!

Did you notice that LADC was not held in 2015?

- It’s because DSN was held in Brazil that year :-)

  The 45th Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN'2015)

- SRDS was held twice in Brazil: 2004 & 2018

  The 26th IEEE Symposium on Reliable Distributed Systems (SRDS 2007)

  The 37th IEEE International Symposium on Reliable Distributed Systems (SRDS'2018)

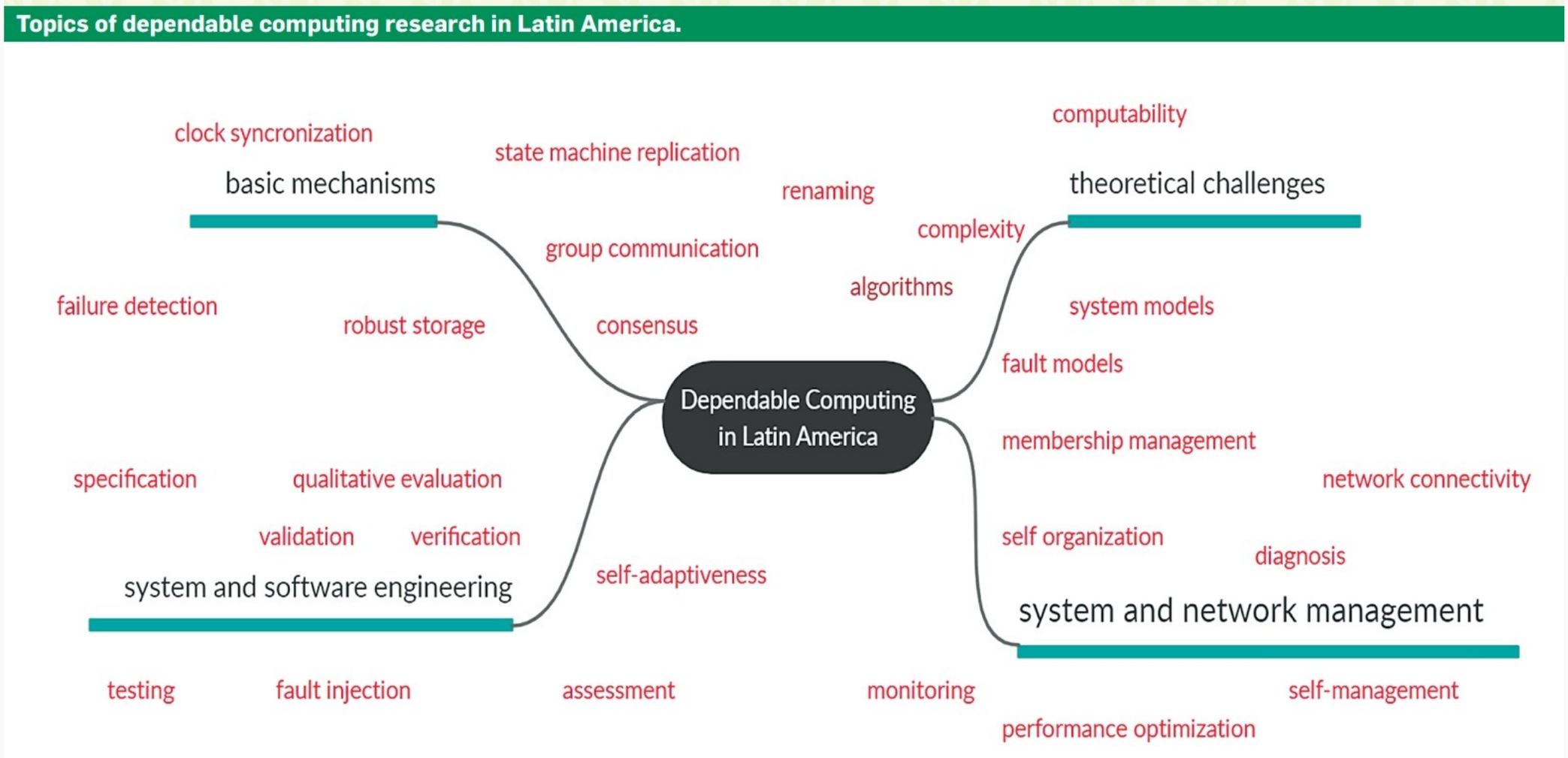
- *PODC has been held in Mexico, and ISSRE’2025 in Brazil*
- *among many others...*

And... WTF!

- The Brazilian Workshop on Fault-Tolerant Computing
- This year in the 26th edition
- A national workshop, with most papers published in Portuguese
- The first edition was held in Porto Alegre in 1998 organized by Ingrid Jansch-Porto & Taisy Weber

A Tour of Dependable Computing Research in Latin America

- Multiple aspects of dependable computing



Disclaimer

- For the CACM article, the main researchers that are mentioned were contacted… but not for this presentation
- Apologies if your favorite work is not listed, or your favorite photo…
- Many apologies also for those not listed here… no space, no time, despite of your great contributions!
- Just write me a message and I can change for the next version of this presentation ;-)

INPE (São Paulo)

- Ana Maria Ambrosio & Fatima Mattielo Francisco together with Eliane Martins (UNICAMP) developed ATIFS: A Test Environment with Fault Injection by Software
- Also worked on integrating model checking and model-based testing for industrial software development
- Robustness testing of satellites & aerospace software in collaboration with Emilia Villani (ITA)

UNICAMP

- Eliane Martins with Jean Arlat (France) et. al.: seminal work on fault injection for dependability validation:

  “Fault injection for dependability validation: A methodology and some applications” nearly 1,000 citations

- Later: fault injection strategies based on reflective programming and on patterns

UNICAMP

- Eliane Martins with With Regina Moraes (UNICAMP) and Henrique Madeira (Portugal), and Marco Vieira (Portugal - USA): fault injection for risk assessment




UNICAMP

- Cecilia Rubira: seminal work on dependable software based on exception handling mechanisms
- A paper compariing exception handling techniques for object-oriented software with Alessandro Garcia (PUC-Rio, Brazil) is highly cited
- With Andrea Bondavalli (Italy) worked on the dependability of dynamic software product lines

Safety Research @ USP

- João Batista Camargo Jr. has been working for decades on multiple safety projects
- Examples include an evaluation of air traffic controller workloads considering manned and unmanned aircraft systems
- Also anomaly detection in railway and subway systems
- And strategies to improve the confidence in safety analysis

UFRGS @ the southernmost state

- Taisy Weber & Sergio Cechin developed the FIONA fault injection tool for dependability evaluation
- Anubis Rosetto (IFSul, Passo Fundo) got her Ph.D. under the supervision of Claudio Geyer (UFRGS) and in collaboration with Luciana Arantes (France) and have been working on noval failure detection strategies




UFSM (Santa Maria, RS)

- Raul Ceretta (earlier a Ph.D. student of Ingrid Jansch-Porto) has worked on failure detection, and currently on security
- Marcia Pasin (UFSM) and Marcelo Pasin (Switzerland) are brother and sister that work on dependability

PUC-RS

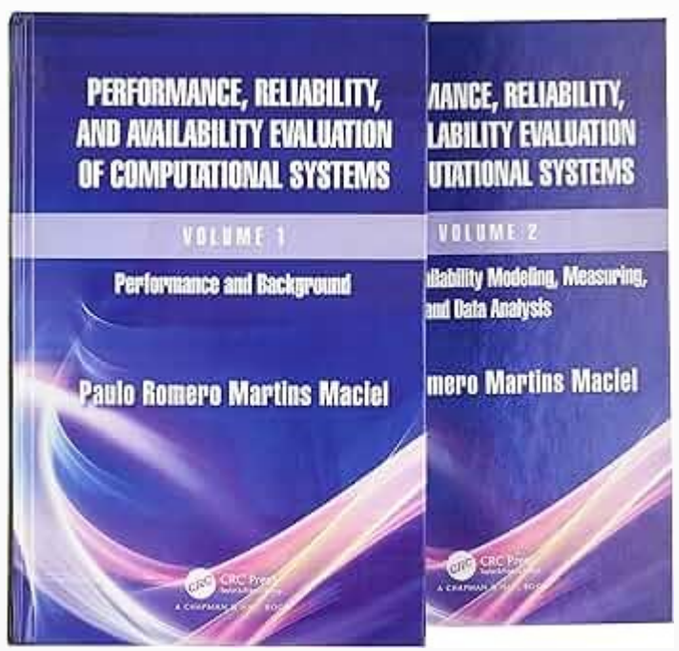
- Fernando Dotti has been working with Fernando Pedone (Switzerland) on several aspects of state machine replication
- Odorico Mendizabal (UFSC) was a Ph.D. working with both Fernandos and is very active in the Latin America dependability scenario

In Rio: UFRJ

- Edmundo Souza e Silva has been also working on dependability modeling, and his Tangram II tool has been widely used by both academia and industry worldwide
- Among his many publications: “The system availability estimator” (FTCS’1995) has ~250 citations

In Recife: UFPE

- Paulo Romero Martins Maciel has also been working on dependability modeling, and and has a 2-volume book on the field
- Among his many publications: “Reliability of wireless sensor networks” & “Dependability modeling” with Prof. Kishor Trivedi (U.S.A.), Rivalino Matias (Brasil), Dong Seong Kim (Australia) have large numbers of citations



Not only Brazil: Mexico!

- Sergio Rajsbaum is a very active researcher with a large number of very well cited publications
- Basically works on distributed systems theory, has cooperated with Idit Keidar (Israel), Roy Friedman (Israel), Michel Raynal (France) and many others
- His previous student Armando Castañeda has also established himself as a professor/researcher in this field

Joni Fraga * UFSC * Florianópolis

- Joni Fraga coined the term “intrusion tolerance” in 1985:
  - “A fault-and intrusion-tolerant file system” with David Powell (France)
- The term has been adopted worldwide and became truly popular years later as the number of Internet security problems increased
- Multiple other works, in distributed systems and networking and related fields, and several of his students became relevant researchers in the field...

UnB * Brasília, the Capital

- Eduardo Alchieri is one of Joni Fraga's Ph.D. students that became a dependability professor
- Alysson Bessani (Portugal) has a large number of relevant contributions to the field and was also Joni Fraga Ph.D. student
- Together they won the DSN Test Of Time Award in 2024 for their DSN'14 paper on the BFT-SMaRt replication library
- Other Joni students include the late Lau Cheuk Lung and Rogerio de Lemos (UK)




UFBA: right here in Bahia

- Raimundo Macedo proposed the concept of causal blocks to represent group message ordering
- Based on this concept, with Paul Ezhilchelvan (UK) and Santosh Shrivastava (UK) they proposed one of the early group communication systems: NewTop
- Macedo with Sergio Gorender (UFBA) and Michel Raynal (France) proposed a hybrid distributed systems model



More Bahia!

- Alan Freitas of IFBA, he has been very active in the Latin American dependability community
- Alirio Sá of UFBA, had works on self-manageable group communication, adaptive Byzantine replication, among others
- Macedo with Flavio Assis (UFBA) have proposed mobile process groups with virtual synchrony in the early 1990s



And even more Bahia…

- The late Fabiola Greve
- Several relevant works in the field of distributed computing, to highlight 1: “Consensus in one communication step” with Francisco “Fubica” Brasileiro (UFCG), Achour Mostéfaoui (France) and Michel Raynal (France)

UFCG: Andrey Brito

- Andrey Brito has been working on multiple aspects of dependability, from distributed systems to security
- His Ph.D. thesis was supervised by Christof Fetzer (Germany) with whom he has continued collaborations
- From the same university: Francisco “Fubica” Brasileiro

UFPR Paraná

- Most of my work is on the border, the intersection of Networking and Distributed Systems
- From early work on system-level diagnosis applied to network management, to current work on software-defined in-network computing
- Introduced to dependability by my Ph.D. supervisor, one of the great members of IFIP WG 10.4: Prof. Takashi Nanya (Japan)

More dependability in Paraná etc.

- Several of my previous Ph.D. students are working on the field, some very engaged with the community in Latin America
- Luiz A. Rodrigues (UNIOESTE), Edson Camargo (UTFPR-Toledo), Rogerio Turchetti (UFSM), Vinicius Fulber-Garcia (UFPR), Giovanni Venancio (UFPR)...





And many more!… sorry for not being able to mention everybody…

Thank you!

For more information or suggestions, please contact:

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