Typical mistakes in design, construction and operations of a data center

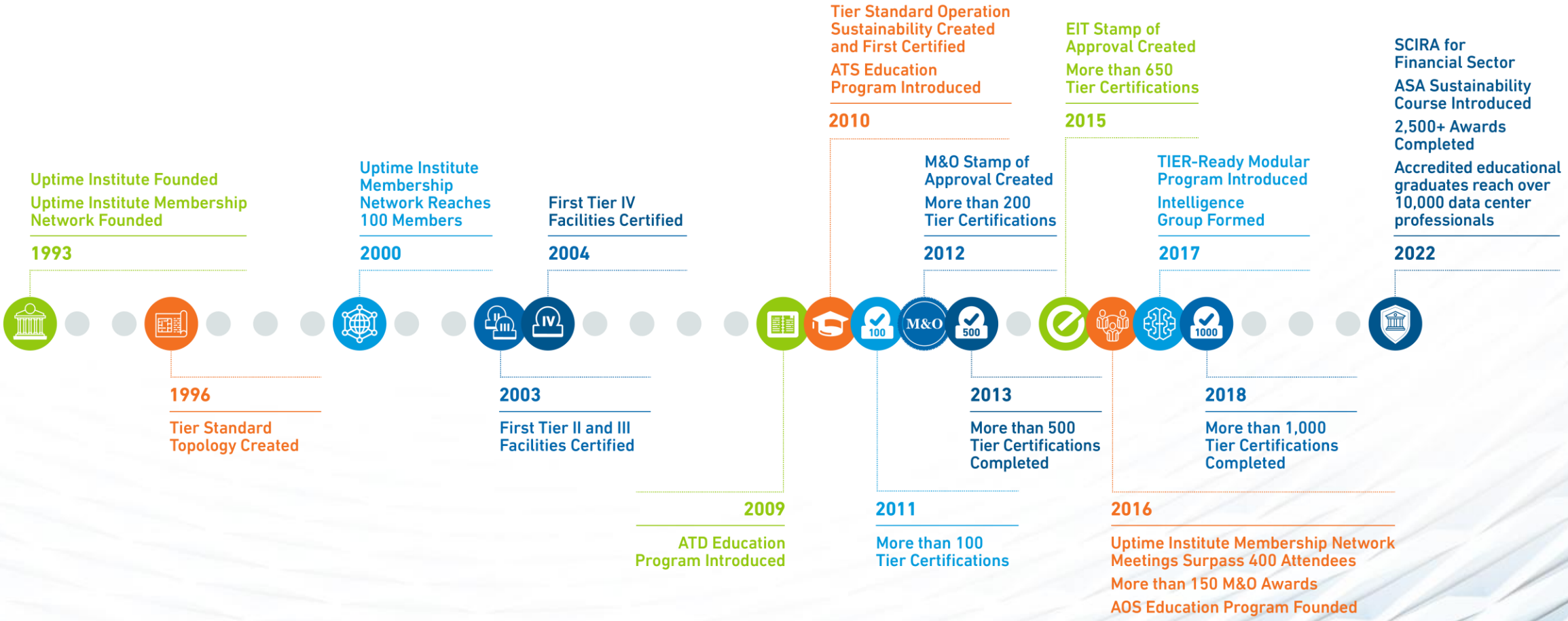
Data-Center as a Basis of a Digital World:
Theory and Practice
Tbilisi, March 29th 2023

Konstantin Korolev

Director, Business Development
Uptime Institute

uptime INSTITUTE

Uptime Institute Timeline



uptime INSTITUTE

Tier Classification:

Tier I: Basic Capacity
(Basic infrastructure with minimal set of components)

Tier II: Redundant Components
(Redundancy for all the active components)

Tier III: Concurrently Maintainable
(Possibility to do planned maintenance of each and every component without affecting the normal operation)

Tier IV: Fault-Tolerant
(Retaining the operability in case of any single fault of any component)

uptime INSTITUTE

OUR COMMON TASK

TO DESIGN, BUILD AND RUN THE DATA CENTER SO THAT IT COULD CARRY ITS MAIN TASK, THAT IS

TO OPERATE OUTSIDE OF BOTH SCHEDULED AND UNSCHEDULED REMOVALS FROM SERVICE OF ITS COMPONENTS

EXPOSURE TO INCIDENTS DEPENDS ON BOTH THE RELIABILITY OF THE SYSTEMS AND THE OPERATIONS OF THE DATA CENTER

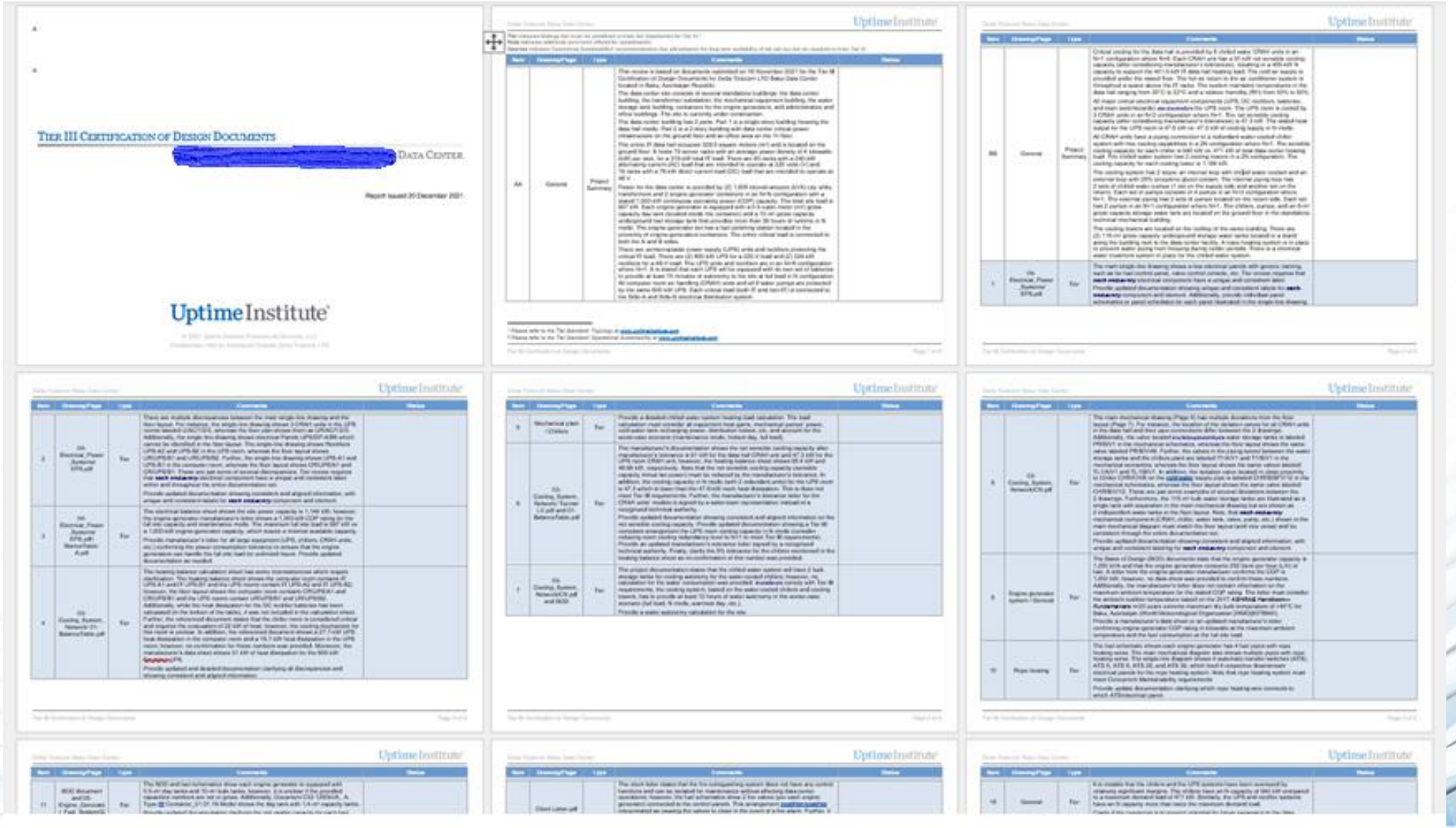
uptime INSTITUTE

Part 1. The reliability of infrastructure, or of the design itself

- Any drawbacks, mistakes, flows, shortcomings and non-optimal solutions in the design documentation can negate the reliability of the data center

- 95% of all errors appear at the design stage

Design Documentation analysis in examples



uptime INSTITUTE

Mistake #1. Failure to comply with Tier requirements

8	Item 3 - Floor Plan of All Critical Spaces Equipment Arrangement	Tier	A layout illustrating the location of all power cable routes has been submitted as part of the project documentation; however, there is no color-coding or any other method of clear identification for A and B power paths. Moreover, it is not fully clear if proper service access is available to the power cables. Provide confirmation that ***each and every*** power distribution component can be isolated and removed for maintenance without the need to remove complementary distribution paths or components so that at least N power and cooling are available during any maintenance operation to meet Concurrent Maintainability requirements.	
12	Item 4 - Electrical Schematics & Single Lines Diagrams	Tier	The single-line diagram shows main Switchgear (РУ-0.4) and the ГРЩ electrical panels as sectioned single panels. Concurrent Maintainability requirements must be applied to ensure that each panel section can be de-energized and isolated for maintenance/replacement without any issues. For such panels, provide a detailed drawing to demonstrate the intersection of the panel isolation. Confirm there are no transit communication cables or bus bars coming through the panel sections that could prevent the removal of a selected panel section.	

Mistake #2. Uniqueness and consistency of labeling elements in drawings

1	04-Electrical_Power_Systems/EPS.pdf	Tier	The main single-line drawing shows a few electrical panels with generic naming, such as for fuel control panel, valve control console, etc. Tier review requires that ***each and every*** electrical component have a unique and consistent label. Provide updated documentation showing unique and consistent labels for ***each and every*** component and element. Additionally, provide individual panel schematics or panel schedules for each panel illustrated in the single-line drawing.
	Item 3 - Floor Plan of All Critical Spaces Equipment		There is inconsistent labeling for the chillers' dry coolers. They are labeled as DC1 and DC2 in some documents, while other documents list them as EC-01A and EC-01B or as ДР1 and ДР2. Moreover, labeling for some other critical cooling components is missing from the floor layout. In addition, the hydro-modules are labeled as HM2.1/HM2.2 and ГМ1.1/1.2 (connected to the critical electrical panels)

Mistake #3. Incorrect power and heat loads calculation, or its absence

			The heating balance calculation sheet has some inconsistencies which require clarification. The heating balance sheet shows the computer room contains IT UPS-A1 and IT UPS-B1 and the UPS rooms contain IT UPS-A2 and IT UPS-B2; however, the floor layout shows the computer room contains CR/UPS/A1 and CR/UPS/B1 and the UPS rooms contain UR/UPS/B1 and UR/UPS/B2.
	Item 4 - Electrical Schematics &		A power load calculation has been submitted; however, there are multiple mistakes and inconsistencies. For instance, according to the power load calculation chart, the full data center load is 1,426 kW, whereas the single-line drawings show the load in Switchgear Section 1 as 1,651 kW. This does not meet Tier III criteria as N engine-generator capacity is only 1,440 kW (continuous rating). If the load
17	Item 10 - Mechanical Load Calculations	Tier	Additionally, for Room #18 (the energy center), it is unclear how the equipment heat gains have been calculated. Only final number are presented, with no explanation as to how the calculation was performed.

Mistake #4. Incorrect consideration of ambient conditions, or equipment performance at such conditions

20	DX cooling system	Tier	It is unclear how the DX systems will work during winter. For instance, the switchgear room (РУ-0.4) CRAC units have a 12-kW stated cooling capacity (it is currently unclear whether this is the gross, net, or net sensible capacity) with a limiting Freon pipe length of 7 meters (m) and allowable outside temperatures between -15°C and +43°C. A similar issue exists for the CRAC units in the energy room, with a DX condenser minimum allowable temperature of only -20°C. Provide an explanation as to how all critical DX systems can start and operate at the ambient extreme low temperature of -42°C. Further, provide a floorplan showing the DX system piping connections from the indoor units to the external outdoor components to confirm Concurrent Maintainability of ***each and every*** distribution path. Confirm that the DX system piping length and height difference will not impact the cooling capacity for all DX systems (if applicable).

Mistake #5. Omission of performance tolerance

3	04-Electrical_Power_Systems/ EPS.pdf/ BlanceTable-A.pdf	Tier	The electrical balance sheet shows the site power capacity is 1,144 kW; however, the engine-generator manufacturer's letter shows a 1,000-kW COP rating for the full site capacity and maintenance mode. The maximum full site load is 997 kW vs a 1,000-kW engine-generator capacity, which leaves a minimal available capacity. Provide manufacturer's letter for all large equipment (UPS, chillers, CRAH units, etc.) confirming the power consumption tolerance to ensure that the engine generators can handle the full site load for unlimited hours. Provide updated documentation as needed.
6	03-Cooling_System_ Network/ Tecnair LV.pdf and 01-	Tier	The manufacturer's documentation shows the net sensible cooling capacity after manufacturer's tolerance is 91 kW for the data hall CRAH unit and 47.3 kW for the UPS room CRAH unit; however, the heating balance sheet shows 95.4 kW and 48.96 kW, respectively. Note that the net sensible cooling capacity (sensible capacity minus fan power) must be reduced by the manufacturer's tolerance. In addition, the cooling capacity in N mode (with 2 redundant units) for the UPS room is 47.3 which is lower than the 47.6-kW room heat dissipation. This is does not meet Tier III requirements. Further, the manufacturer's tolerance letter for the CRAH units' models is signed by a sales team representative instead of a recognized technical authority.

Mistake #6. Discrepancies between drawings

			The main mechanical drawing (Page 6) has multiple deviations from the floor layout (Page 7). For instance, the location of the isolation valves for all CRAH units in the data hall and their pipe connections differ between the 2 drawings.
	Item 4 - Electrical		The main single-line diagram shows that Panel ВРУ АБК1(сущ) connects to an unknown load (Circuit Breakers QF1.4/1.7/1.8/1.13). Clarify this load. Additionally, provide an explanation for all loads connected to Panels ВРУ АБК1(сущ) and ВРУ АБК2(сущ). Confirm whether or not the load is noncritical. In addition, provide an
5	Item 3 - Floor Plan of All Critical Spaces Equipment Arrangement and Item 4 - Electrical Schematics &	Tier	Multiple electrical panels illustrated in the single-line diagram are not present in the electrical equipment floor layout. Such panels are ЩГП3.1, ГМ1.1, and ГМ1.2 as well as a few other. Additionally, electrical Panels ЩУВ1 and ЩУВ2 are shown in the floor layout but cannot be identified in the single-line drawing. Note that ***each and every*** electrical panel illustrated in the single-line drawing must be shown in the floor layout and included in the electrical equipment schedule document.

Mistake #7. Discrepancies in description of components, solutions etc., or its absence

30	General	Tier	The project description document states that there are 10 rows of racks inside the IT data hall and each row contains 12 racks with 2 power connections, for a total of 120 racks. However, according to the electrical diagrams, each row has 13 racks with 2 power connections, which gives a total of 130 racks. Clarify the discrepancy and provide an updated documentation set accordantly.
11	Electrical schema; Uptime English	Tier	The main single-line diagram shows (2) 400-kW UPS for Side-A and for Side-B. However, the Basis of Design (BOD) document (Page 3) states the UPS system has a capacity of 800 kVA/760 kW. Clarify (and confirm with manufacturer's documentation) the UPS output power, in kilowatts, for both mechanical UPS and IT UPS systems.
12	General/ electrical	Tier	UPS battery information was not provided. Clarify the UPS battery configuration, connection, runtime, and charging power calculation and also verify this ride-through time is sufficient to support the maximum load while the engine generators start and close into the critical bus.

Other:

A. Don’t complicate

18	03-Cooling_System_Network/CN.pdf	Operate	The main mechanical schematics show multiple valves which appear to be redundant. For instance, Valves aT2BFV/28, T2BFV/29, and T2BFV/13 and T2BFV/14, T3BFV/13, T3BFV/14, T3BFV/14, CHR/V/6, CHR/V/11, CHR/V/2, PR/V/11, PR/V/6, PR/V/14, and a few others.
			While these valves are not required to meet Tier III requirements, consideration should be given to removing these valves to save some costs against any operational impact.

B. Don’t be formal and use common sense

Yes, 28+1 is Tier III too, but why??

Part 2.
Of spherical cows, or
Any design can be spoiled if you want

uptime INSTITUTE

DC Construction

When a data center is being designed it exists only on paper. Be focused on the construction phase to get the DC built in accordance with the design.

Pay attention to:

- Site location
- Building characteristics
- Indoor and outdoor spaces
- Internal logistics
- Mutual arrangement of subsystems
- Operational aspects
- FULL LOAD TEST

uptime® INSTITUTE

Building characteristics must correspond to its purpose

uptime INSTITUTE

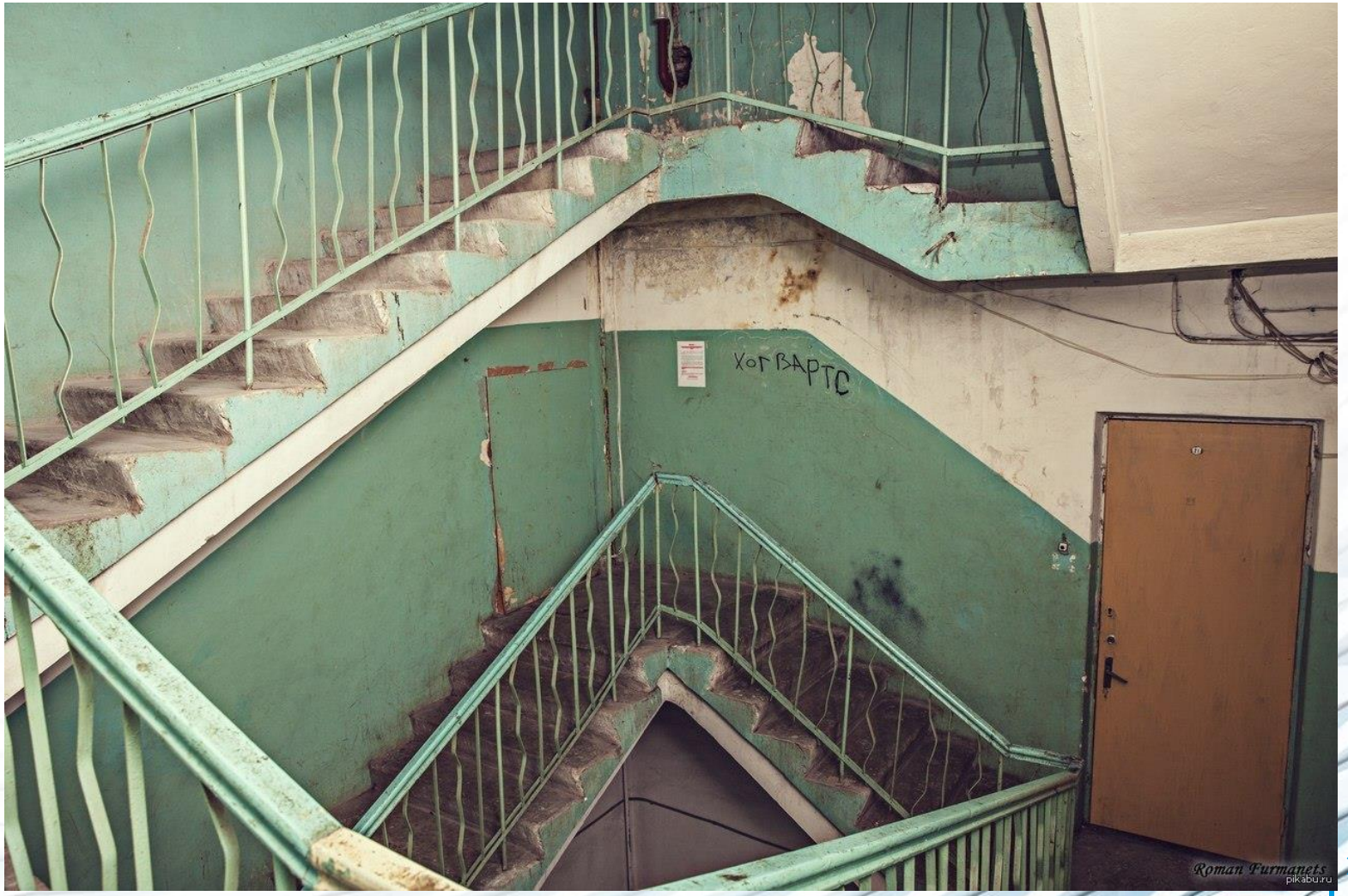
Take into account characteristics of both building and equipment

uptime INSTITUTE

Don’t forget elevators. It’s not only about size and capacity, but redundancy too

uptime INSTITUTE

Passages, doors, stairs, ceilings, sills, ramps and so on can be surprising



uptime INSTITUTE

Think of those who will run it

When separate systems come into conflict

Don’t buy a sports car for the countryside

uptime INSTITUTE

Part 3. Even the most reliable data center can go down due to poor operations

uptime INSTITUTE

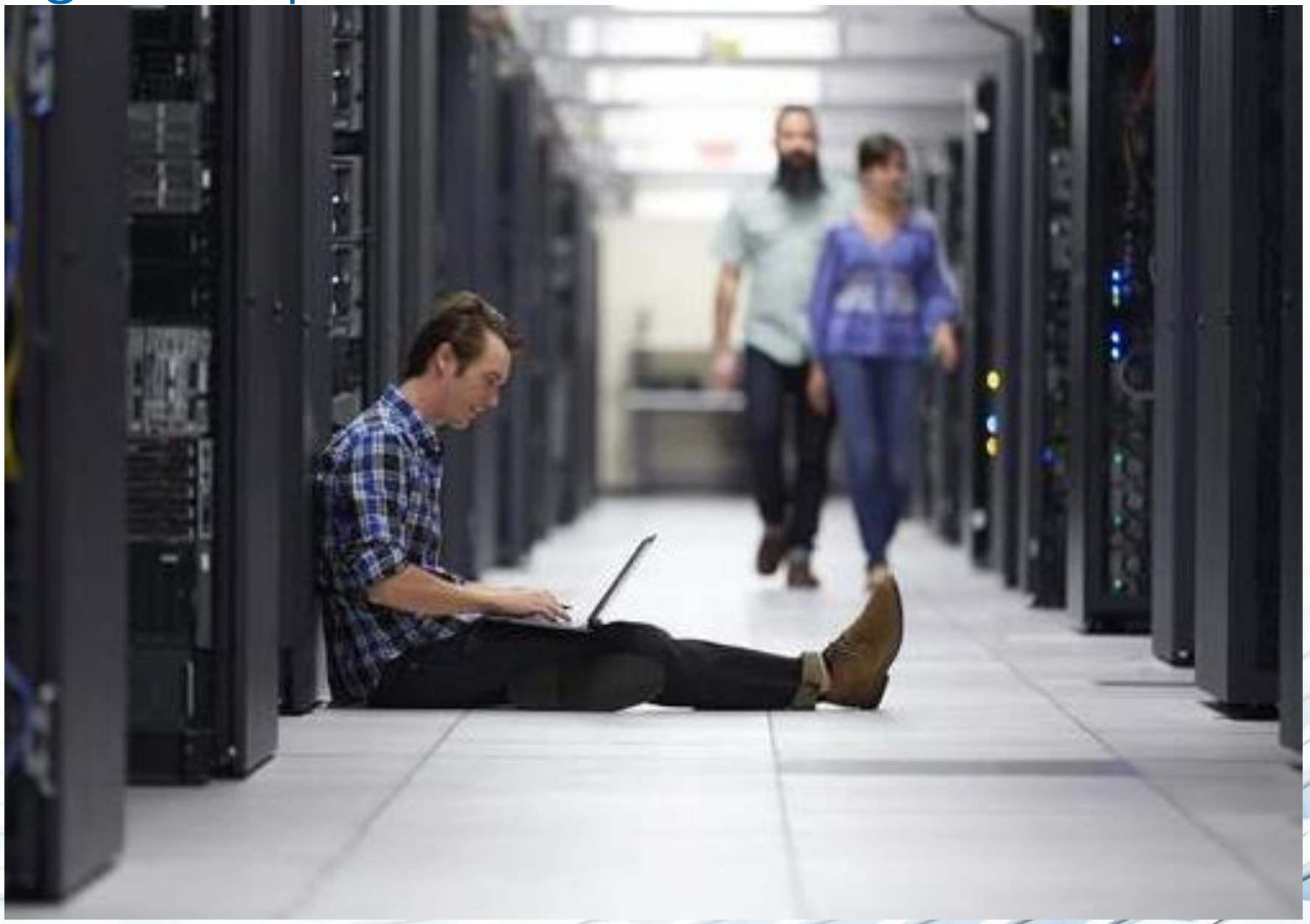
You can build a data center of any Tier…

But ensure you have appropriate and sufficient resources to run it

- Site policies
- Standard / emergency procedures
- Documentation and access to it
- Trainings & drills
- Maintenance
- Spare parts, storage, instruments
- Housekeeping
- Staff

uptime INSTITUTE

What is wrong in the picture?



uptime INSTITUTE

Staff is the first and main asset of a DC

2 major causes of incidents are:

– Somebody hasn't done something what was necessary

– Somebody has done something what was unnecessary

uptime INSTITUTE

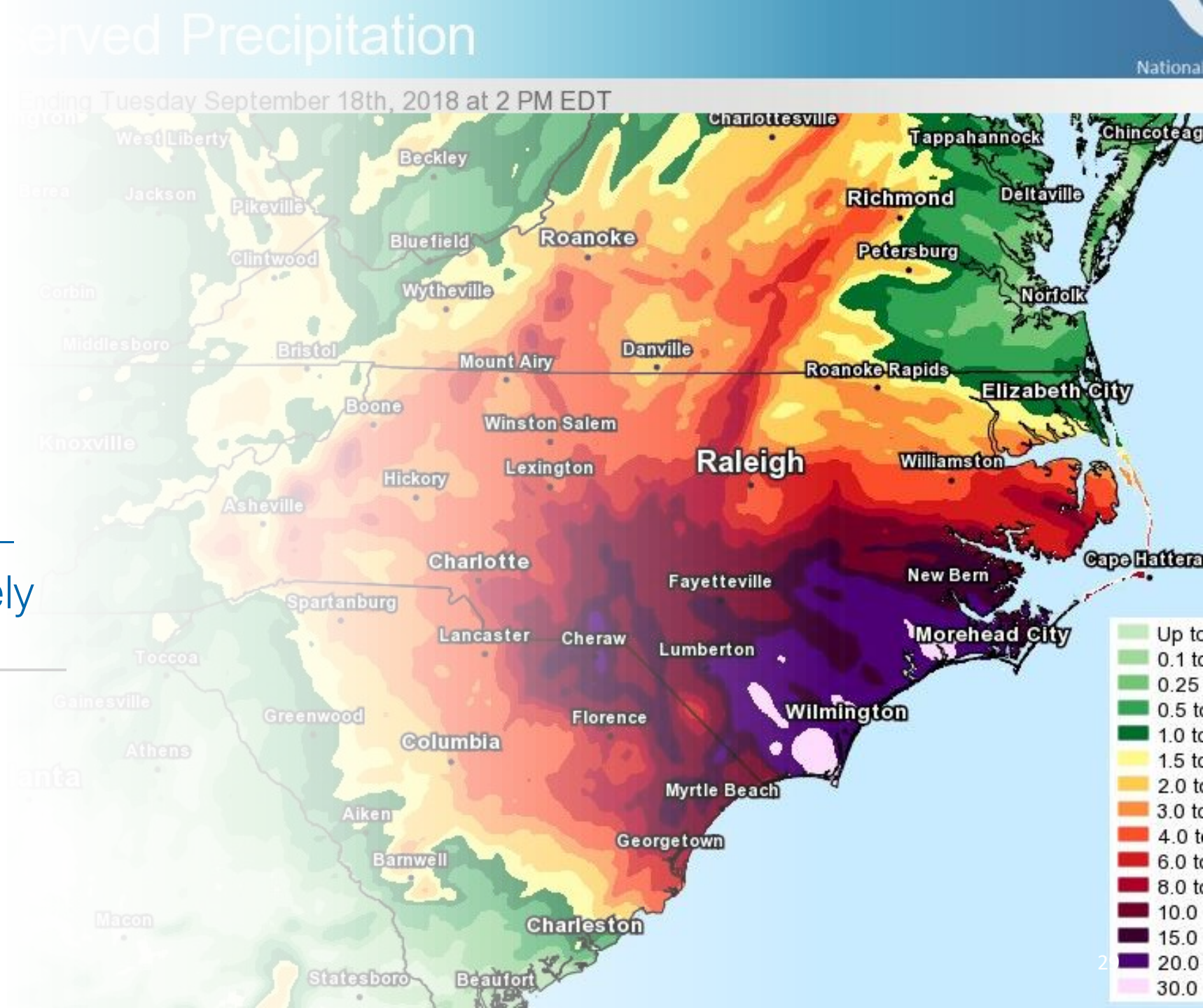
Irreplaceable Employee

Never rely on a single person – it will ruin your operations some day

uptime INSTITUTE

Extreme weather conditions

Sometimes it may be hot – both literally and figuratively



uptime INSTITUTE

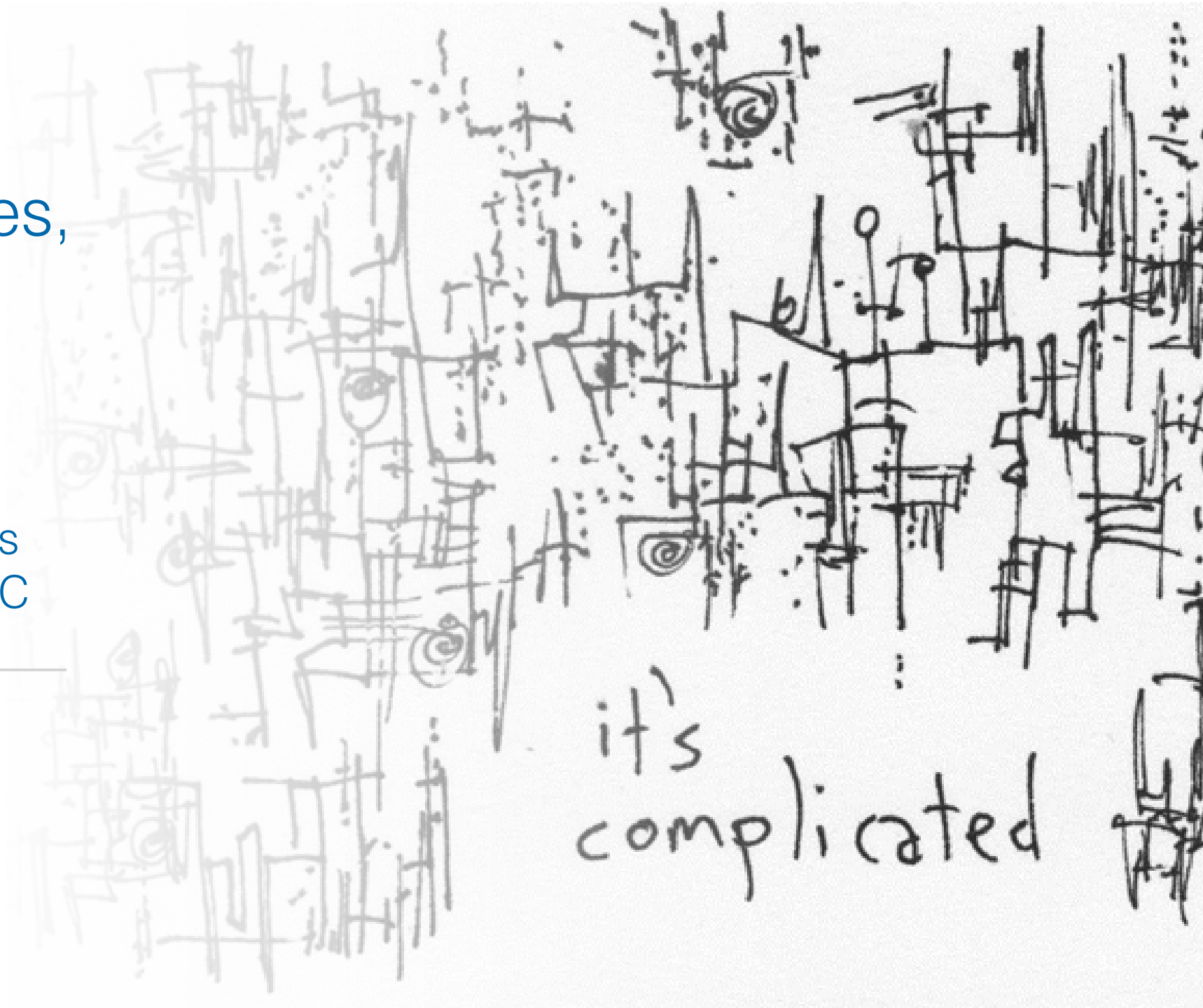
DC overload

It’s easy as one-two-three – Just plug more servers to any outlets

uptime® INSTITUTE

Policies, processes, procedures

Be bold and hasty! There's no better way to get the DC down



uptime® INSTITUTE

Poor maintenance

Maintain the equipment timely and properly. It's crucial

uptime® INSTITUTE

Safety

Courage and stupidity are not welcomed

uptime® INSTITUTE

Housekeeping

No comment. Just do it.

uptime® INSTITUTE

Afterword

1. Mind the business task when defining the DC concept. Don't under- or overestimate your objectives

2. Do not get carried away by either innovation or conservatism

3. Define the operations model at the very beginning, so that you had your staff ready at the zero day

4. Never lose focus on routine operations

5. Work with professionals and learn every day

Konstantin Korolev

Director, Business Development

+7 916 642 6603

kkorolev@uptimeinstitute.com

©2022 Uptime Institute, LLC.
All Rights Reserved.

Uptime Institute
405 Lexington Avenue
New York, NY 10174